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and Science of Surgery

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SURGERY

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No. 1

Original Communications

THE LOCAL IMPLANTATION OF SULFANILAMIDE IN COMPOUND FRACTURES

A PRELIMINARY REPORT

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(From the Minneapolis General Hospital and the Department of Surgery, University of Minnesota Medical School)

HISTORICAL

THE principle of surgical excision of devitalized and contaminated tissue from traumatic wounds was first recognized and followed by Petit¹ in the early part of the eighteenth century. Larry,² surgeon to Napoleon, a century later again called attention to this principle, but even after careful débridement in compound fractures "hospital gangrene" occurred so frequently that amputation remained the prevailing practice. Lister,³ in 1867, published his first paper on the principle of antiseptic surgery, reporting in detail eleven cases of compound fractures which he had treated with carbolic acid packs. Lister's selection of compound fractures as the proving ground for the idea of antiseptics which Pasteur's work had given him testifies to the temerity of the man, for open fractures still remain the most common traumatic wounds to develop severe infection.

The development of aseptic surgery which followed Lister's work and the better understanding of wound infections gained from the discoveries of bacteriology resulted in progress along these two fundamental principles of treatment of contaminated wounds. Aseptic surgery allowed the effective reduction of the number of bacteria present in a wound and the removal of their best culture media by excision of contaminated and devitalized tissue. Antiseptic agents were developed in abundance, but all suffered from the same defect as Lister's carbolic acid; for, if capable of injuring a pathogenic organism, they were even more capable

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of injuring normal tissue. This severely limited their use as it soon became evident that even the strongest were incapable of complete sterilization of a wound; hence, all that resulted was a yet contaminated, now further devitalized wound. The introduction of neutral hypochlorite of soda by Dakin and its use by Carrel and Dehelly* in war wounds is perhaps an exception. Yet it must be used with meticulous care if its irritating propensity is not to outweigh its bacteriostatic effect. Furthermore, technical difficulties make it almost impossible to treat both the fracture and the compound wound simultaneously using Dakin's solution. For this reason its employment has been limited in compound fractures.

TABLE I*
FREQUENCY OF VARIOUS FRACTURES
METHODS OF TREATMENT AND INCIDENCE OF INFECTION

METHOD OF R	TIBIÆ FIBULÆ		RADII, ULNÆ		PHALANGES METACARPALS		FEMORA		HUMERI	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
	17	54.8	7	22.6	4	12.9	1	3.2	2	6.5
Primary suture	15	88.2	7	100.0	3	75.0	1	100.0	2	100.0
Open wound	1	5.9			1	25.0				
Dakin's	1	5.9								
Cast	12	70.6	7	100.0	3	75.0			1	50.0
Traction	2	11.8					1	100.0	1	50.0
Amputation to control infection	3	17.6								
Traumatic amputation	1	5.9			1	25.0				
Gas gangrene	1	5.9								
Infection	4	23.5	1	14.3	1	25.0	1	100.0	1	50.0

Summary: 31 open fractures } Incidence of infection, 25.8%
 5 became infected }

*Detailed analysis of the incidence of the various open fractures, their treatment as to method and the incidence of infection occurring in 1932. Thirty-one fractures were treated with an average elapsed time of two hours and forty minutes from time of fracture to beginning of débridement. The average age of the group was 35.8 years. No deaths occurred.

PRESENT STATUS OF TREATMENT

Because of the limitations inherent in all chemical bacteriostatic agents, therapy has improved only with development of mechanical means of preventing infection; that is, débridement, immobilization, postural control of swelling, and stimulation of circulation. These

TABLE II
ANALYSIS OF TREATMENT AND RESULTANT INFECTION FOR 1932

METHOD OF R	PRIMARY SUTURE	OPEN WOUND	DAKIN'S	CAST	TRACTION
No. of cases	28	3	1	23	4
Cases (%)	90.3	9.6	3.2	74.2	12.0
No. of infections	5	3	1	4	2
Infections (%)	17.8	100	100	17.4	50

TABLE III
FREQUENCY OF VARIOUS FRACTURES
METHODS OF TREATMENT AND INCIDENCE OF INFECTION

METHOD OF R	FIBULAE TIBIAE		RADII, ULNAE		PHALANGES METACARPALS		FEMORA		HUMERI	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
	21	52.5	7	17.5	5	12.5	3	7.5	4	10
Primary suture	17	80.9	6	85.7	4	80.0	2	66.6	3	75
Open wound	3	14.3	1	14.2	1	20.0	1	33.3	1	25
Dakin's	1	4.7								
Cast	5	23.8	6	85.7	4	80.0			2	50
Traction	12	57.1					2	66.6	2	50
Amputation to control infec- tion			1	16.7						
Traumatic amputation	1	4.7			1	20.0	1	33.3		
Gas gangrene			4	57.1	1	20.0				
Infection	5	23.8	3	43.0	2	40.0			1	25

Summary: 40 open fractures } Incidence of infection, 27.5%
11 became infected }

Detailed analysis of the incidence of the various open fractures, their treatment as to method, and the incidence of infection occurring in 1937. Forty fractures were treated with an average elapsed time of 3 hours and 15 minutes from time of fracture to beginning of débridement. The average age of the group was 41.6 years. Five deaths occurred, all within 72 hours, 4 as result of head injury, one from rupture of the liver, giving a mortality of 12.5%. All came to autopsy.

measures, together with tetanus and gas gangrene antitoxin, have given excellent results as compared with the dismal situation of Lister's time. Yet, the incidence of severe wound infections following compound fractures remains in the neighborhood of 10 per cent under ideal circumstances and in the best hands. Böhler⁵ reports 8.66 per cent severe wound infections in 127 cases of open fractures. He quotes 14 per cent for Koch in 213 cases; 8.6 per cent for Ehalt in 127 cases; and 17.3 per cent for Schmidt in 116 cases. American authors report approximately the same figures. Ritter² reports 9 per cent infection; Foster,⁶ 15.7 per cent. Poyner,⁷ dealing with industrial fractures treated under ideal conditions, reports only 6.3 per cent in 269 cases. The remarkably low incidence reported by Poyner is explained by the fact that from the moment of fracture these cases received expert care by trained first-aid men. Definitive treatment was expert and early, and few were "street wounds."

Municipal hospitals in America, dealing largely with "street wounds" sustained by direct trauma and produced by high speed projectiles

TABLE IV
ANALYSIS OF TREATMENT AND RESULTANT INFECTION FOR 1937

METHOD OF R	PRIMARY SUTURE	OPEN WOUND	DAKIN'S	CAST	TRACTION
No. of cases	32	7	1	17	16
Cases (%)	80	17.5	2.5	42.5	40
No. of infections	8	3	1	7	5
Infections (%)	25	42.8	100.0	41.2	31.2

of injuring normal tissue. This severely limited their use as it soon became evident that even the strongest were incapable of complete sterilization of a wound; hence, all that resulted was a yet contaminated, now further devitalized wound. The introduction of neutral hypochlorite of soda by Dakin and its use by Carrel and Dehelly⁴ in war wounds is perhaps an exception. Yet it must be used with meticulous care if its irritating propensity is not to outweigh its bacteriostatic effect. Furthermore, technical difficulties make it almost impossible to treat both the fracture and the compound wound simultaneously using Dakin's solution. For this reason its employment has been limited in compound fractures.

TABLE I*
FREQUENCY OF VARIOUS FRACTURES
METHODS OF TREATMENT AND INCIDENCE OF INFECTION

METHOD OF R	TIBIAE FIBULAE		RADII, ULNAE		PHALANGES METACARPALS		FEMORA		HUMERI	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
	17	54.8	7	22.6	4	12.9	1	3.2	2	6.5
Primary suture	15	88.2	7	100.0	3	75.0	1	100.0	2	100.0
Open wound	1	5.9			1	25.0				
Dakin's	1	5.9								
Cast	12	70.6	7	100.0	3	75.0			1	50.0
Traction	2	11.8					1	100.0	1	50.0
Amputation to control infection	3	17.6								
Traumatic amputation	1	5.9			1	25.0				
Gas gangrene	1	5.9								
Infection	4	23.5	1	14.3	1	25.0	1	100.0	1	50.0

Summary: 31 open fractures } Incidence of infection, 25.8%
8 became infected }

*Detailed analysis of the incidence of the various open fractures, their treatment as to method and the incidence of infection occurring in 1932. Thirty-one fractures were treated with an average elapsed time of two hours and forty minutes from time of fracture to beginning of débridement. The average age of the group was 35.8 years. No deaths occurred.

PRESENT STATUS OF TREATMENT

Because of the limitations inherent in all chemical bacteriostatic agents, therapy has improved only with development of mechanical means of preventing infection; that is, débridement, immobilization, postural control of swelling, and stimulation of circulation. These

TABLE II
ANALYSIS OF TREATMENT AND RESULTANT INFECTION FOR 1932

METHOD OF R	PRIMARY SUTURE	OPEN WOUND	DAKIN'S	CAST	TRACTION
No. of cases	25	3	1	23	4
Cases (%)	90.3	9.6	3.2	74.2	12.9
No. of infections	5	3	1	4	2
Infections (%)	17.8	100	100	17.4	50

TABLE VI

ANALYSIS OF TREATMENT AND RESULTANT INFECTION FOR FIRST THREE MONTHS OF 1938

METHOD OF R	PRIMARY SUTURE	OPEN WOUND	CAST	TRACTION
No. cases	19	3	16	19
Cases (%)	86.4	13.2	72.7	86.4
No. infections	6	1	1	4
Infections (%)	31	33.3	6.2	21.0

are frequent. Various methods of therapy have been tried without affecting this incidence. From the tables it is evident that dakinization resulting in 100 per cent infection is not the answer. Leaving the wounds open after débridement and packing with vaseline or cod liver oil ointment gauze and application of circular casts (Orr treatment) was less effective than primary suture after débridement. Immobilization in plaster with traction if necessary for maintenance of complete reduction did give better results than traction alone and was the method used most frequently.

COMPOUND FRACTURE TREATED WITH SULFANILAMIDE

The work of Colebrook and co-workers^{10, 11} and of Long and Bliss^s revealed the effective principle of prontosil to be its reduction product para-aminobenzenesulfonamide or sulfanilamide and demonstrated its in vitro bacteriostatic properties in dilutions of $\frac{1}{10,000}$ and higher. Subsequently, it became well known that this agent could be given subcutaneously and intraspinally in supersaturated solutions of 1 per cent without causing any local tissue damage. Furthermore in vitro studies showed its bactericidal and bacteriostatic properties to be augmented greatly in concentrations higher than could safely be obtained by systemic administration.* With these considerations in mind, one of us (N. K. J.), after complete débridement of a compound fracture of both bones of the forearm, placed 5 gm. of sulfanilamide in the wound before closure. This case was selected for our first try because of the seeming surety of infection.

The patient, a boy 12 years of age, had fallen 70 feet from a cliff into the Mississippi River. He sustained a compound fracture of both bones of the right forearm, a simple fracture of both bones of the left forearm, serious head injury, and damage to the right kidney resulting in prolonged hematuria. Three hours elapsed before the patient was brought to the hospital and, on admission, he was in profound shock. Four hours of intensive therapy, including 500 c.c. of citrated blood plus intravenous glucose, brought his blood pressure above the critical level and his body temperature from 96° to 98.6° F. Then, seven hours after injury, débridement and closure were carried out. The wound was found packed with mud driven deeply into the marrow cavities of the proximal fragments. The distal radioulnar joint and the ulnocarpal articulation were torn open and grossly contaminated. The flexor tendons were exposed and the substances of the pronator quadratus and flexor carpi

*Ranging around 1 part in 10,000.

(automobiles), cannot approximate results such as Poyner's or Böhler's by current methods of treatment. A survey of the records for 1932 embracing 32 compound fractures treated at the Minneapolis General Hospital reveals 25.8 per cent infection. Five years later, in 1937, 40 open fractures resulted in 27.5 per cent infection. These figures include all in which a purulent discharge developed and are not limited to those showing frank osteomyelitis. Yet, examination of these statistics, Tables I to VIII, shows 5 cases of gas gangrene in 1937 and 1 amputation to control infection. In 1932 3 amputations were necessary to control infection, and 1 case of gas gangrene occurred. In both series prophylactic serum was routinely used. In the first three months of 1938, 22 open fractures were treated by us in exactly the same manner as the cases to follow except that sulfanilamide was not used. Infection occurred in 27.2 per cent and there was 1 case of gas gangrene which came to amputation.

This percentage of infection is high; however, when one reviews the material treated at this hospital, the primary healing of over 70 per cent without any evidence of infection seems a triumph. Here we are not dealing with well-fed, employed workmen in good health, but with those on relief, many of whom find themselves there because of pre-existing debilitating diseases. Many are alcoholics and the incidence of delirium tremens is high. Practically all are unwashed and wearing badly soiled clothing. *Tabes dorsalis* is common and serious concomitant injuries

TABLE V
FREQUENCY OF VARIOUS FRACTURES
METHODS OF TREATMENT AND INCIDENCE OF INFECTION

METHOD OF R	TIBIAE FIBULAE		RADII, ULNAE		PHALANXES METACARPALS		FEMORA		HUMERI	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
	14	63.6	3	13.6	1	4.5	4	18.3		
Primary suture	12	85.7	3	100.0	1	100.0	3	75.0		
Open wound	2	14.3					1	25.0		
Dakin's										
Cast	8	57.1	3	100.0	1	100.0				
Traction	8	57.1			1	100.0	2	50.0		
Amputation to control infection	1	7.1								
Traumatic amputation	1	7.1					2	50.0		
Gas gangrene	1	7.1								
Infection	4	28.6					2	50.0		

Summary: 22 open fractures, total } Incidence of infection, 27.2%
6 became infected }

Detailed analysis of the incidence of the various open fractures, their treatment as to method, and the incidence of infection occurring in the first three months of 1938. Sulfanilamide was not used, however, in the treatment of any of these fractures.

Twenty-two fractures were treated with an average elapsed time of 3 hours from the time of fracture to beginning of débridement. The average age of the group was 33 years. One death occurred at 5 hours due to a crushing injury of the chest, giving a mortality of 4.5%. This case came to autopsy.

TABLE VI

ANALYSIS OF TREATMENT AND RESULTANT INFECTION FOR FIRST THREE MONTHS OF 1938

METHOD OF R.	PRIMARY SUTURE	OPEN WOUND	CAST	TRACTION
No. cases	19	3	16	19
Cases (%)	86.4	13.2	72.7	86.4
No. infections	6	1	1	4
Infections (%)	31	33.3	6.2	21.0

are frequent. Various methods of therapy have been tried without affecting this incidence. From the tables it is evident that dakinization resulting in 100 per cent infection is not the answer. Leaving the wounds open after débridement and packing with vaseline or cod liver oil ointment gauze and application of circular casts (Orr treatment) was less effective than primary suture after débridement. Immobilization in plaster with traction if necessary for maintenance of complete reduction did give better results than traction alone and was the method used most frequently.

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The work of Colebrook and co-workers^{10, 11} and of Long and Bliss⁸ revealed the effective principle of prontosil to be its reduction product para-aminobenzenesulfonamide or sulfanilamide and demonstrated its in vitro bacteriostatic properties in dilutions of $\frac{1}{10,000}$ and higher. Subsequently, it became well known that this agent could be given subcutaneously and intraspinally in supersaturated solutions of 1 per cent without causing any local tissue damage. Furthermore in vitro studies showed its bactericidal and bacteriostatic properties to be augmented greatly in concentrations higher than could safely be obtained by systemic administration.* With these considerations in mind, one of us (N. K. J.), after complete débridement of a compound fracture of both bones of the forearm, placed 5 gm. of sulfanilamide in the wound before closure. This case was selected for our first try because of the seeming surety of infection.

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*Ranging around 1 part in 10,000.

ulnarus were badly macerated. Five gm. of sulfanilamide was placed in the wound before closure. The patient was afebrile after three days and the wound healed promptly without drainage. Due to extensive loss of substance of the radius, increased during débridement by the necessity of rongeur away the dirty bone, approximation of the fragments was not obtained. Six weeks after surgery this gap was closed by a sliding bone graft with resultant prompt union.

Absence of suppuration in this wound with immediate healing per primum was so encouraging that all compound fractures since have been treated by introduction of crystalline sulfanilamide into the wounds after completion of meticulous débridement. These wounds are closed tightly by interrupted sutures of silk to the skin only. Closure without tension on the wound is accomplished when necessary by longitudinal splitting of the skin away from the site of the wound but parallel to the closure. Complete reduction is obtained at the time of débridement in all cases and absolute immobilization accomplished by immediate application of unpadded plaster splints held in place by either circular bandage or plaster. Reduction is maintained by continuance, when necessary, of skeletal traction in conjunction with the plaster splints.

TABLE VII
FREQUENCY OF VARIOUS FRACTURES
METHODS OF TREATMENT AND INCIDENCE OF INFECTION

METHOD OF R	TIBIÆ FIBULÆ		RADII ULNÆ		PHALANGES META- CARPALS		FEMORA		HUMERI		COMPOUND DISLO- CATIONS	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
	16	39.0	13	31.7	7	17.1	1	2.4	2	4.9	2	4.9
Primary suture	16	100.0	13	100.0	7	100.0	1	100.0	2	100.0	2	100.0
Open wound												
Dakin's	16	100.0	13	100.0	7	100.0			1	50.0	1	50.0
Cast	16	100.0					1	100.0	2	100.0	1	50.0
Traction												
Amputation to control infection												
Traumatic amputation												
Sulfanila- mide per os	5	31.2	6	46.2	1	14.3			1	50.0	1	50.0
Sulfanila- mide lo- cally	16	100.0	13	100.0	7	100.0	1	100.0	2	100.0	2	100.0
Infection	2	12.5										

Summary: 41 open fractures } Incidence of infection, 4.9%
2 became infected }

Detailed analysis of the incidence of the various open fractures, their treatment as to method, and the incidence of infection occurring in the last nine months of 1939. Sulfanilamide was used locally in all wounds.

Forty-one fractures were treated with an average elapsed time of 2 hours and 50 minutes from the time of fracture to the beginning of débridement. The average age of the group was 22 years. Three deaths occurred, all within 72 hours, 1 from rupture of the spleen and 2 from head injuries. All cause to autopsy.

Casts are not windowed and the wound is left untouched until such time as consolidation of the fracture allows replacement of splints by circular casts prior to ambulatory treatment. The minimum of 000 plain catgut suture material to accomplish hemostasis is buried in these wounds; no attempt is made to suture any deep structures except nerves.

TABLE VIII
ANALYSIS OF TREATMENT AND RESULTANT INFECTION

METHOD OF R	PRIMARY SUTURE	OPEN WOUND	CAST	TRACTION	SULFANILA- AMIDE PER OS	SULFANILA- AMIDE LOCAL
No. cases	41	--	35	17	14	41
Cases (%)	100.0	--	85.4	41.5	34.1	100
No. infections	2	--	2	2	1	2
Infections (%)	4.9	--	5.5	11.8	7.1	4.9

To date, thirty-nine compound fractures and two compound dislocations have been treated by this method (Tables VII and VIII). In two cases, both tibiae, one eight days and the other twelve days after reduction, the fractures were recomponded and subsequently became infected. The other thirty-seven healed by primary intention without local or systemic evidence of wound infection. Including the two cases in which the fractures were recomponded, the incidence of infection is 4.88 per cent. We do not feel, however, that these two cases represent primary wound infection. Briefly their histories are:

H. S., 39-year-old white male, was admitted to the Minneapolis General Hospital July 5, 1938, in shock and drunk, one hour after being struck by an automobile. He had sustained compound fractures of both tibiae and of both bones of the right forearm. Intensive treatment of the shock, including 1,000 c.c. of citrated blood, allowed débridement and reduction to be undertaken two hours after admission. Seven and one-half grams of sulfanilamide were placed in each tibial wound and 5 gm. in the forearm. The patient was a known chronic alcoholic and had been on a prolonged spree. Eight hours after admission he developed delirium tremens. Heavy sedation with paraldehyde and chloral kept him fairly quiet, however, and by the seventh day he was afebrile. The Stimson splints were windowed* over the wounds on the fifth day and the wounds were healing per primum. On the seventh day, due to general improvement, sedation was discontinued but, on the evening of the eighth day, the patient suddenly became maniacal and drove the proximal fragment of the right tibia through the healing skin wound at the site of the window in the splint. Severe infection followed with osteomyelitis due to *Staphylococcus aureus*. His other wounds healed without infection.

G. E., aged 65 years, sustained a compound "bumper" fracture of the right tibia on Nov. 4, 1938. Routine débridement with introduction of 10 gm. of crystalline sulfanilamide into the wound and primary closure were carried out three hours after injury. On the third day the patient was afebrile and remained so. However, x-rays three weeks later showed sharp anterior angulation at the fracture site due to insufficient traction. On the twenty-eighth day after added traction had failed to accomplish correction, the Stimson splints were removed to allow manipulative correction. The proximal fragment was found to have eroded its way through the

*A subsequently regretted exception to our practice.

wound and was surrounded on the sides by healthy granulations. The ventral surface was clean and viable and there was no evidence of suppuration. Sterile vaseline gauze dressings were applied and the position corrected with immobilization in circular plaster. Four weeks later the odor was characteristic of osteomyelitis and change of the cast at this time revealed purulent drainage.*

Both of these cases illustrate poor management of the fractures, not of the compound wounds. Accurate reduction must be maintained, particularly in subcutaneous bones, and windowing of casts only increases motion at the fracture site. Inspection of a healing wound is of no therapeutic value. The circumstances leading to infection in these wounds convince us that both represent reinfected wounds.

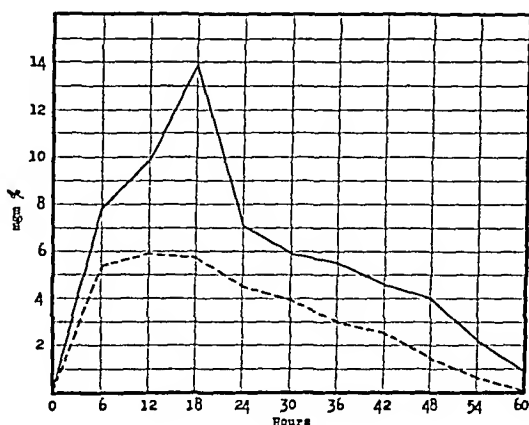


Fig. 1.—Blood concentrations of sulfanilamide in two patients after 10 gm. and 6 gm., respectively, had been buried in operative wounds.

EXPERIMENTAL

Sulfanilamide crystals buried in a wound should dissolve slowly, the drug finding its way into general circulation over a period of many hours. During this time theoretically the serum, hematoma, and local tissues of the wound are saturated with sulfanilamide at 0.8 per cent concentration, the solubility of this compound at body temperature. These considerations suggest that by placing sufficient crystalline drug in the area of contamination a concentration approaching 800 mg. per cent should be maintained for a considerable length of time. In comparison, systemic medication with sulfanilamide attempts to attain only 10 to 20 mg. per cent in the blood. Hence, by local introduction of the drug with subsequent closure of the wound, a concentration eighty times that obtained by systemic medication apparently is assured for a prolonged period in the contaminated area. This concentration is bactericidal for organisms more susceptible to sulfanilamide and, from animal experiments now in progress, appears sufficiently bacteriostatic

*One month subsequent to the submission of this paper for publication, this wound had healed without evidence of osteomyelitis, and has remained so to date (6/19/34). The corrected percentage of osteomyelitis for this series is 2.7.

TABLE IX
CONCENTRATION OF SULFANILAMIDE IN OPERATIVE WOUNDS*

AMOUNT PLACED IN WOUND	HOURS SINCE CLOSURE OF WOUND	LOCAL CONCENTRATION IN MG. %	BLOOD CONCENTRATION
5 gm.	24 hr.	666.5	2.7 mg. %
10 gm.	26 hr.	509.0	----
8 gm.	30 hr.	250.0	5.9 mg. %

*These determinations were made on filtered serum aspirated from operative wounds. Only the concentration of free sulfanilamide was determined.

even for *Staphylococcus aureus hemolyticus* to prevent infection of compound fractures.

Actual measurement of the rate of absorption and excretion of sulfanilamide in two patients in whom known amounts were placed in surgical wounds (Fig. 1) reveals that approximately sixty hours are required for the drug to disappear from the blood. It reached its highest level in the blood after approximately eighteen hours in both cases. Marshall and co-workers²⁹ studies of excretion of sulfanilamide show after a single large dose by mouth that practically all the drug is eliminated in twenty-four hours. This would indicate that in the two cases studied here active absorption continued from the wound for at least thirty hours, although the rates of excretion exceeded absorption the last twelve of the thirty hours. Aspiration of serums and unorganized blood from wounds in which various amounts of the drug have been placed substantiate these deductions (Table IX). These studies are too few for definite conclusions, yet they demonstrate the validity of the theoretical foundation for the local use of sulfanilamide. Further studies now are in progress.

Experimental study of the ability of sulfanilamide to prevent infection of compound fractures in animals was carried out by fracturing the ribs of twenty-seven guinea pigs and contaminating the wound with *Staphylococcus aureus hemolyticus*. The staphylococcus culture had been obtained recently from the blood of a 13-year-old youth dying of pyemia associated with an acute osteomyelitis of the humerus. The

TABLE X
CONTROL SERIES, NO SULFANILAMIDE*

ANIMAL	RESULT
No. 1	Wound draining on 4th day
No. 2	Wound draining on 6th day
No. 3	Wound draining on 7th day
No. 11	Wound draining on 8th day
No. 9	Sacrificed on 3rd day†
No. 8	Healed on 8th day
No. 10	Healed on 9th day

Incidence of infection, 71.4%; no mortality

*Compound fracture of rib in guinea pig. Wound heavily contaminated with *Staphylococcus aureus hemolyticus* and skin edges sutured tightly.

†Autopsy of pig showed osteomyelitis of rib, acute pleurisy, bronchopneumonia. Cultures of wound and heart's blood revealed *Staphylococcus aureus hemolyticus*.

fractures were produced by exposing the rib through the overlying muscles and cutting it with a pair of scissors. Contamination was accomplished by flooding the wound with the original blood culture of the organism. All wounds except one (No. 17) were tightly closed with skin sutures of silk. No dressings were applied and the animals then were allowed the run of their cages.

TABLE XI
EFFECT OF 0.5 GM. SULFANILAMIDE SYSTEMICALLY*

ANIMAL	RESULT
No. 13	Wound draining 4th day
No. 19	Wound draining 6th day
No. 25	Wound draining 6th day
No. 26	Wound draining 6th day
No. 27	Wound draining 4th day
No. 20	Wound draining 6th day
No. 22	Died 4th day, autopsy†
No. 23	Died 8th day, autopsy†
No. 21	Healed 8th day
No. 24	Healed 8th day

Incidence of infection, 80%; mortality, 20%

*Compound wound identically prepared, contaminated, and closed as in control series. 0.5 gm. crystalline sulfanilamide placed subcutaneously in abdominal wall.

†Both pigs showed acute pleurisy, bronchopneumonia, and severe wound infection. Blood and wound culture revealed *Staphylococcus aureus hemolyticus*.

Consideration of the results reported here (Tables X to XII) reveals that out of seven controls five developed severe wound infection with osteomyelitis of the rib, while two healed without suppuration. In ten animals in which 0.5 gm. of sulfanilamide was placed in the wound before closure, seven healed promptly. One, sacrificed on the third day, showed no evidence of wound infection, but, on culture, *Staphylococcus aureus hemolyticus* was recovered from the wound. We feel safe, however, in assuming that this wound would not have become infected since it showed none of the edema and necrosis found in the control wounds (Nos. 9 and 17) also posted on the third day. In ten animals in which

TABLE XII
EFFECT OF 0.5 GM. SULFANILAMIDE LOCALLY*

ANIMAL	RESULT
No. 4	Healed per primum
No. 12	Healed per primum
No. 14	Healed per primum
No. 15	Healed per primum
No. 5	Healed per primum
No. 6	Healed per primum
No. 7	Healed per primum
No. 16	Sacrificed 3rd day (see autopsy)
No. 17	Infected at 8th day†
No. 18	Infected at 8th day†

Incidence of infection, 20%; no mortality

*Compound wound identically prepared and contaminated as in Table XI; 0.5 gm. sulfanilamide crystals placed in wound before tight closure.

†Wound left gaping, allowing drug to drain away with serum; result, infection.

‡Subjected to 3 cardiac punctures in 3 days, removing 10 c.c. blood; result, infection.

the fracture wound was produced as in the controls and contaminated with the same culture, the sulfanilamide was buried subcutaneously in a second wound on the abdomen. One, sacrificed on the third day, showed gross pus in the wound with edema and necrosis of the tissue. Seven developed osteomyelitis and two healed. From this it appears that systemically administered sulfanilamide is not effective, for infection is as frequent in this group of animals as in the control group. The two animals of the locally treated group which developed wound infections deserve mention as in one animal (No. 17) the wound was intentionally not tightly closed, but left gaping several millimeters with two loose sutures through the skin. This was done to see if it made any difference when sulfanilamide crystals, once having been placed in the wound, were allowed to escape with the serous exudate subsequently developing in such an open wound. Apparently it does. Animal 18 had cardiac punctures on the first, second, and third postoperative days to obtain blood for chemical study. This represented a loss of about 10 c.c., considerable for an animal of this size, and may have influenced the outcome. This factor, dosage, effect of particulate matter, diet, etc., and the efficacy against different strains of staphylococcus and other micro-organisms are now being studied.

These limited experimental studies demonstrate that in a wound heavily contaminated with a freshly isolated virulent resistant organism the local presence of a high concentration of sulfanilamide allows the natural local defensive factors to handle the infection in 80 per cent of the cases. In identical wounds with the same dosage of bacteria and systemically administered sulfanilamide, 80 per cent of the wounds became infected, while those receiving no sulfanilamide show 65 per cent infection.

SUMMARY

The local use of sulfanilamide has opened the way for more effective treatment of contaminated wounds. The amount to be used in each specific wound depends upon the extent of trauma and contamination. Twenty grams seems the upper limit advisable in any adult patient; less should be used in children. Five to fifteen grams have been found sufficient for average to very severe wounds.

Complete painstaking débridement aseptically carried out by frequent changes of instruments and gloves, followed by saline irrigation with primary closure of the wound without tension by interrupted sutures, still remains the fundamental treatment of contaminated wounds. Sulfanilamide will not protect against gross contamination of a badly devitalized wound containing much foreign infectious material, as it is apparently only bacteriostatic against staphylococcus, even in concentrations approaching 1 per cent. However, if the dirty and

devitalized tissue has been removed and good physiology re-established and maintained, sulfanilamide in concentrations obtainable by local introduction of the crystalline drug in sufficient amounts, by its bacteriostatic effect, will protect against infection by holding the organisms in check until local defensive forces have responded and are able to overcome the bacteria.

Good wound physiology demands immediate definitive reduction with complete immobilization maintained by traction and plaster splints where applicable. In brief, our treatment of compound fractures is thorough débridement and careful hemostasis, followed by the introduction of 5 to 15 gm. of crystalline sulfanilamide into the wound with primary closure of the skin avoiding tension. We then concentrate on treatment of the fracture. Every effort is made to accomplish complete reduction and thereafter to hold the fragments absolutely still. Excessive edema is avoided by appropriate elevation and the patient's systemic needs are met by transfusion, sedation, and intelligent medical care.

The treatment of thirty-nine compound fractures and two compound dislocations by these principles has resulted in not a single instance of primary wound infection. Two tibiae were recompound; both became infected. Ninety-four open fractures treated by similar methods, except that sulfanilamide was not used, showed 27 per cent infection, seven cases of gas gangrene and five amputations to control infection.

Dr. A. A. Zierold, Professor of Surgery at the University of Minnesota and Chief of the Surgical Service at the Minneapolis General Hospital, showed constant interest and gave helpful suggestions in the conduct of the study. Miss Betty Hanson and Miss Cora Evenson performed the sulfanilamide determinations.

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INTERNAL FIXATION OF TROCHANTERIC FRACTURES OF THE FEMUR

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DURING the past few years a great deal of emphasis has been placed on the so-called intracapsular fractures of the hip and this has been referred to as the unsolved fracture, while the trochanteric fractures of the femur have been relatively neglected. This is probably because these fractures tend to unite regardless of the treatment and the chief problem which they present from the standpoint of local treatment is the obtaining of union without crippling deformity, the chief deformities being coxa vara and external rotation of the distal fragment. However, it is to be noted that from the standpoint of mortality the trochanteric fractures are more serious than are the so-called intracapsular fractures of the hip; and in a recent series which we have reported from the St. Louis City Hospital the mortality of the 214 trochanteric fractures was 38 per cent, while the mortality of 166 intracapsular fractures in the same hospital was 25.9 per cent. It is thus evident that not only are they more frequent, but the mortality of the trochanteric fractures is considerably greater than is that of the intracapsular fractures, even when they are treated by the same methods (Rowlette and co-workers¹).

Since the introduction of internal fixation of the intracapsular fractures of the hip by Smith-Petersen in 1930, the mortality of these fractures has been greatly reduced where internal fixation is used routinely. We were rather slow to use the Smith-Petersen nail, because in the beginning we believed that the method of performing an open reduction and inserting the nail through a large anterolateral incision was too formidable a procedure to be undertaken lightly in the type of patients who suffer fractures of the hip. Since learning a method by which we are able to insert the nail satisfactorily with local anesthesia and practically no surgical shock (Key²), we have been enthusiastic in its use.

The introduction of practical methods of internal fixation in intracapsular fractures of the hip not only has resulted in the obtaining of satisfactory union in a much higher percentage of these cases than we obtained by so-called conservative methods, but it has greatly reduced the mortality. And we believe that this is important, in spite of the fact that little has been said about the mortality in the literature on the so-called conservative treatment of fractures of the hip. The chief concern has been whether or not the patients obtained bony union, and to

judge from the literature it almost seems as though a fracture of the hip has a distinct rejuvenating effect on an aged individual.

In observing the postoperative course of patients in whom a fracture through the neck of the femur has been satisfactorily nailed or fixed by pins or a lag screw, one is impressed by the facts that they are relatively free from pain, move about in bed with relative ease, can be gotten out of bed within a few days if necessary, spend a relatively short time in the hospital, are not troubled with weakness of the legs and stiffness of the joints after their hip has united, and can resume their usual activities several months sooner than can the smaller percentage of similar patients who have obtained union under the so-called conservative method. I reiterate the term "so-called conservative treatment" because I believe that the truly conservative method of treating a fracture through the neck of the femur is to operate upon it and fix the fragments firmly together by whatever method the surgeon prefers, always providing that a surgeon capable of performing the operation skillfully and accurately is available, because the operation is not easy and requires special skill and training.

In trying to explain the high mortality of trochanteric fractures, we first have considered the fact that the trochanteric fractures occur in patients who are slightly older than are a similar group of patients who suffer fractures through the neck of the femur. The average age of the 214 patients in our series of trochanteric fractures was 66.6 years, while the average age of the 166 patients who suffered fractures through the neck of the femur was 63.8 years. That age is an important factor in the mortality of each group is indicated by the facts that the average age of the patients with trochanteric fractures who died was 73.8 years, while the average age of those who survived was 60 years; and the average age of the patients with fractures through the neck of the femur who died was 71.2 years and the average age of those who lived was 60.9 years.

It is also to be noted that the patient with a trochanteric fracture has usually suffered a more severe initial injury than has the patient with a fracture through the neck of the femur. In a fracture through the neck of the femur the head is usually twisted off of the neck with relatively little violence and the fragments are not comminuted or markedly displaced and there is little hemorrhage or damage to the soft tissues. In a trochanteric fracture the bone is broken by force transmitted up the extremity or by direct violence, as in a fall on the trochanter, and the fragments are usually comminuted with considerable displacement and hemorrhage and damage to the soft tissues.

In view of the above it is reasonable to believe that the patients with trochanteric fractures suffer more pain than do those with fractures through the neck of the femur, and clinical observations lead me to believe that they do. I also believe that one of the principal debilitating

factors and causes of death in these old people with fractures of the hip is pain. Another important factor in the mortality is immobilization of the patient, either by plaster-of-Paris casts or by traction.

The Smith-Petersen nail and its substitutes have saved many lives because they have relieved the patients of pain and have freed them from casts and splints. Even if the results were no better than by other methods, nailing would still be the humane way of treating fractures of the hip.

We have tried various methods of treating the trochanteric fractures, namely, walking plaster-of-Paris casts, the well-leg traction splints, abduction plasters, abduction plasters with traction, and the Hodgen's splint. Of the various methods at our disposal it has seemed to us that the Hodgen's splint, when properly used, made the patients more comfortable, permitted them more freedom in moving around in bed and in sitting up in bed, and obtained a better anatomic and functional result than any method which we have tried. However, the mortality has remained about the same.

In an effort to reduce this mortality we have tried to develop a method by which these fractures could be operated upon and immobilized in a manner similar to that in which our intracapsular fractures are now either nailed or pinned. In the beginning we hoped for a method which would fix these trochanteric fractures to the same degree and afford the same freedom from casts and splints and permit the patient to be gotten out of bed soon after the operation, as is the case in the fractures through the neck of the femur which have been nailed. However, it seems evident that this is not possible, because of the tendency to comminution and of the rather wide variation in the type of fracture encountered.

It now appears that it is possible, however, to so fix most, if not all, of these trochanteric fractures that the patient will be made comfortable and that he may rest in bed or move around in bed without any external splintage, unless it be merely a small weight on the leg with Buck's extension and a small pillow under the knee. This can be done by open operation and in some fractures it can be done with the Smith-Petersen nail or, if preferred, with the Moore pins; while in others it can be done with wires, the type of internal fixation depending largely upon the shape of the bone fragments and the location of the fracture.

The chief difficulty in this operation is that one is very apt to splinter the lateral cortex if one attempts to drive the nail through it without first cutting a channel for the nail. In order to obviate this we have first reduced the fracture; then, with a 3/16-inch drill, have perforated the outer cortex in the direction in which it is desired that the nail be driven and have then cut three channels for the flanges of the Smith-Petersen nail, using a small thin osteotome. In this manner it is possible to drive the nail through the outer cortex and up into the head of the

femur. We have experimented with longer nails placed lower down on the shaft of the femur, but do not believe that they are necessary and find that they are a good deal more difficult to insert.

Viewed from the standpoint of the operative procedure, trochanteric fractures fall into three groups: (1) Fractures through the base of the neck or trochanteric region with little or no visible comminution or displacement. These require no manipulative reduction and can be nailed or pinned blindly or by whatever method the surgeon chooses and the operation can be done through the straight lateral incision. These are treated as are fractures through the neck of the femur, except that the novocain is placed around the fracture and not in the hip joint and a channel is cut through the lateral cortex for the nail and the fragments are impacted very gently. The final position of the nail is checked by anteroposterior and lateral x-rays taken before the wound is closed and developed while the wound is being sutured (Key²). (Fig. 1.)



Fig. 1.—Trochanteric fracture with very slight displacement, before and after nailing. No reduction necessary. Nail should extend farther into the head, but in this instance there were no complications.

2. The usual trochanteric fracture with considerable separation and comminution, but with the lateral cortex of the shaft of the femur intact up to or beyond a point about in line with the superior surface of the neck of the femur. After manipulative reduction these are nailed through a lateral incision or by direct exposure through an oblique incision as is described below. (Figs. 2 to 7.)

3. Fractures involving the lateral cortex of the femur below the level of the line through the superior surface of the neck of the femur. These are really subtrochanteric fractures and cannot be nailed, but can be fixed with wires or a Parham band so that the fragments are fairly stable. (Fig. 7.)

OPERATIVE TECHNIQUE

Unless the patient is in a condition of shock, the operation is performed as soon after the patient is admitted to the hospital as possible. Before the patient is removed from bed, 20 to 30 c.c. of 1 per cent solution of novocain is injected into the hematoma at the site of the fracture. This can be done by directing the needle downward and inward on the anterolateral surface of the thigh at the level of the fracture and aiming at the line of the fracture as determined by the x-ray. When the needle is in the hematoma, blood can be drawn back into the syringe. Then the patient is placed on an ordinary operating table with a tunnel under him to facilitate placing the carrier for the x-ray films under the hip. The entire limb is painted with tincture of mer-



Fig. 2.—Trochanteric fracture before and after satisfactory nailing.



Fig. 3.—Same as Fig. 2, anteroposterior and lateral views, showing the guiding drill in position.

thiolate or iodine and the limb so draped that it can be manipulated by the operating team.

The skin is infiltrated in the line of the incision with 1 per cent novocain which contains three drops of adrenalin to the ounce. Then the deeper tissues are infiltrated with 0.5 per cent novocain which also contains three drops of adrenalin to the ounce. After the skin and deeper tissues have been infiltrated with novocain, the extremity is rotated inward to about 30 degrees beyond the midposition. If the fragments are displaced, strong manual traction is made on the extremity and then it is rotated inward about 30 degrees and abducted about 30 degrees. The limb is maintained in this position by an assistant until the nail has been driven home into the head of the femur. When the lateral x-rays are being taken, the internal rotation and abduction are maintained while the hip is carefully flexed to about 90 degrees.



Fig. 4.—Trochanteric fracture incompletely reduced, with guiding drill in position. Drill is too high.

The straight lateral incision begins on the lateral surface of the thigh opposite the tip of the trochanter and extends downward for 5 or 6 inches. It is carried down through the deep fascia to expose the lateral surface of the trochanter and the vastus lateralis muscle. This muscle is split in its upper 2 inches and its origin cut from the side of the trochanter to expose the lateral surface of the femur below the trochanter.

The anterior surface of the trochanteric region and the base of the neck now can be palpated and it is possible to determine roughly the accuracy of the reduction and the position of the neck and head of the femur. If the reduction is not satisfactory, the limb can be manipulated again while the surgeon's finger palpates the line of the fracture. It is to be noted that the smaller fragments and the lesser trochanter are ignored and that one attempts only to restore the two major fragments to a satisfactory functional position.

At a point as low down on the lateral surface of the shaft as is consistent with passing the nail through the neck of the femur, a 3/16-inch drill is inserted for a distance of about 3 inches. This point is about 1 inch below the base of the trochanter and the drill is directed upward and inward towards the center of the head, as determined by palpation and the preoperative x-rays. If reduction by traction has been necessary, due allowance for this is made in directing the drill. The direction of the drill in the anteroposterior plane is controlled by keeping the drill horizontal; since the long axis of the neck of the femur lies approximately in the horizontal plane when the foot is rotated inward about 30 degrees. (Fig. 4.)



Fig. 5.—Same as Fig. 4, after nailing. The nail was shifted downward from the course of the drill, but did not extend far enough into the head and on the left the nail had slipped three weeks later.

With the drill point in place and binding the two major fragments together, anteroposterior and lateral x-rays now are made. This latter can be done by carefully flexing the hip to 90 degrees while maintaining the internal rotation and moderate abduction. While these films are being developed, the drill is removed and the exact length of the drill point which has entered the bone is noted, as this will aid in determining the length of nail to be used in this case. Now, with a small thin osteotome, three channels are cut for the flanges of the Smith-Petersen nail. This cutting of the channels must be done carefully and gently; otherwise, one may split the cortex. When completed they should permit driving the nail with relatively little resistance. After the channels have been completed, the drill is reinserted and with this size drill no difficulty is encountered in pushing it back into the hole in the head if the extremity has not been moved while it was out.

If the x-rays show the drill to be pointing in the proper direction, it is withdrawn and a Smith-Petersen nail of the proper length is driven

home into the head of the femur, directing it as nearly as possible in the line taken by the drill. If the surgeon has difficulty in keeping this line in mind while the nail is being substituted for the drill, a small drill can be placed in the shaft about $\frac{1}{2}$ inch from and parallel to the drill which is directed towards the head of the femur, and this can then be used as a guide in directing the nail. The length of nail desired is determined by adding the distance of the tip of the drill from the articular surface of the head, as seen in the x-rays, to the length of the drill which penetrated the bone.

If the position of the drill is not satisfactory, then the nail is started in the drill hole with the three channels for the flanges of the nail cut around it and is not driven in the direction taken by the drill, but is tilted up or down or forward or backward as much as necessary to direct it towards the center of the head of the femur and is then driven home. The fragments are then impacted very gently and anteroposterior and lateral x-rays are made. The wound is closed without drainage and if the position of the nail is found to be satisfactory the patient is placed in bed with a small pillow under the knee and with the leg in a position of slight abduction.



Fig. 6.—Same as Fig. 5, showing nail being driven back into the head with a pin and on the right the nail is driven far into the head of the femur.

If the final x-rays show that the nail is not fixed firmly in the head of the femur, the wound is opened immediately and the nail is withdrawn and driven in again in the corrected direction.

If the surgeon prefers, a cannulated nail driven over a Kirschner wire guide may be used, or he may use one of the several instruments now on the market which are supposed to aid in placing the nail properly. Likewise, he may expose the fracture through an oblique

incision and drive the nail under direct vision in a manner similar to that used by Cubbins, Callahan, and Scuderi.³ We prefer this method when we are using a general anesthetic, as the guiding drill and preliminary x-rays are not necessary and consequently the time consumed in the operation is shorter.

In the subtrochanteric fractures it is not possible to use a nail, but in old, debilitated patients the fracture can be exposed and reduced under local anesthesia and the fragments so fixed with wires that good position can be maintained with a slight amount of traction or in a single low spica cast (Fig. 7).

We have not used the Moore pins because we routinely use the Smith-Petersen nail. However, I believe that the pins will work equally well, and they have the advantage that they can be drilled through the lateral cortex without danger of splitting it. In our series the cutting of the channels for the flanges of the nail has been a satisfactory solution and we have not split the lateral cortex. But we are careful not to try to sink the head of a nail with tapering flanges deeply into the cortex.



Fig. 7.—Subtrochanteric fracture before and after open reduction and fixation with wire. Nailing not possible in this type.

POSTOPERATIVE CARE

The postoperative care of patients in whom a trochanteric fracture has been nailed is usually more difficult than is that of an intracapsular fracture which has been subjected to the same procedure. In the trochanteric fracture the fragments are not so firmly bound together and we maintain the extremity in abduction with a pillow under the knee. The patient may sit up at will, but the leg must be lifted and supported on pillows when the patient is turned on the sound side. At the end

of from two to four weeks the patient may sit on the edge of the bed and dangle the feet or even be helped into a chair, but weight-bearing and even walking on crutches without weight-bearing are discouraged until union is quite firm. Very heavy patients do better in a fracture bed, but the average patient prefers an ordinary hospital bed.

When properly inserted, the nail stabilizes the hip sufficiently to prevent outward rotation of the distal fragment and also sufficiently to prevent it from being displaced forward or backward or inward or outward. And usually it prevents the development of a coxa vara. However, in comminuted trochanteric fractures x-rays should be taken about two weeks after nailing and if there is any tendency to a slipping up of the distal fragment (coxa vara), traction (10 to 15 pounds) should be applied to the extremity until the deformity is corrected and the fracture is fairly well healed.

The period during which these patients must remain in bed will depend largely upon the type of fracture and upon the adequacy of the immobilization. If adequate immobilization can be secured, as was done in the case of the patient shown in Fig. 1, the patient may be permitted out of bed on crutches at the end of two weeks. On the other hand, in fractures such as that illustrated in Fig. 7, the period of rest in bed must be prolonged to from eight to twelve weeks or whenever union appears sufficiently solid. In this patient a plaster spica cast was applied to the hip two weeks after the operation and he was sent home to convalesce.

DIFFICULTIES

In nailing a series of fifteen trochanteric fractures we have had no operative infection and no immediate mortality, but two of the patients died about six months after the injury. Each of these patients was over 80 years of age and apparently the fracture of the hip had healed and was not definitely related to the terminal illness. We believe that as the series is increased the mortality will be about 10 per cent.

In internally fixing trochanteric fractures we have encountered certain difficulties which we believe can be avoided by more care, experience, and skill on the part of the surgeon. In my first case the nail was driven through the head of the femur and into the floor of the acetabulum. This can be avoided if it is remembered that in a comminuted trochanteric fracture the base of the neck may be telescoped into the trochanteric region and the distance from the lateral cortex to the head of the femur may be $\frac{1}{2}$ inch or more less than it is in the normal hip. In nailing a fracture of this type a relatively short nail should be used (Fig. 2).

A more frequent mistake is not to reduce adequately the fracture before the nail is inserted or to fail to maintain reduction. After displacement has occurred, these fractures cannot be reduced and locked by

internal rotation and abduction as can an intracapsular fracture. Consequently, unless care is taken to prevent it the fracture may be nailed with a varus deformity. (Figs. 4 and 5.)

A third mistake which we have made is not driving the nail deeply enough into the firm cancellous bone of the head. In one instance a nail backed out during the fourth week after the operation. It was driven back in place with a pin inserted through a small incision under local anesthesia (Figs. 5 and 6).

It is to be emphasized that the nailing of a trochanteric fracture in which the fragments have been displaced requires more care and skill on the part of the surgeon than does the reduction and nailing of an intracapsular fracture. However, it is possible to nail practically all of these fractures under local anesthesia and with practically no shock to the patient and we believe that if these fractures are nailed properly there will result a very definite decrease in the mortality which, as has been noted above, is higher than is the mortality of the intracapsular fractures. It is also to be emphasized that these fractures cannot be fixed as firmly as the intracapsular fractures and that postoperatively the patients must remain in bed longer and require more care than do patients in whom intracapsular fractures have been nailed successfully.

CONCLUSIONS

1. Trochanteric fractures occur more frequently than do intracapsular fractures of the hip.

2. The mortality is greater in trochanteric fractures than it is in intracapsular fractures of the hip.

3. It is believed that internal fixation of trochanteric fractures will appreciably reduce the mortality and add much to the comfort of the patients.

4. Methods of internally fixing trochanteric fractures are described.

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DISCOID CARTILAGE, TRIGGER KNEE

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AN ARTICLE by Middleton¹ in the October, 1936, issue of the *British Journal of Surgery* gives the bibliography and the historical events in cases of discoid cartilage from 1889 to the present time. There is a reference to the classical study of Jaroschy, of Prague, and the information is given that forty-nine cases of this condition have been reported to date.

It has been well recognized by several writers that discoid cartilage represents a persistence of the embryonic external semilunar cartilage. There is also a reference to Fisher's article, in which he considers the relation of trigger knee to cystic degeneration of the external semilunar cartilage.

There have been three recognized cases in the past few years at the Boston Children's Hospital and one adult private case of mine. These cases are reported in detail:

CASE 1.—E. B. (A147,162), female, aged 4½ years. Admitted, Oct. 23, 1933; discharged, Nov. 16, 1933.

History.—Admitted for pain in the left knee of two months' duration. Child's mother gave a history of snapping sensation in the knee when it was straightened out. No other complaints and no history of injury.

Physical Examination.—General physical examination negative. Local examination showed a clicking sound in the left knee which occurred during extension. Something could be felt to snap when the knee was in about 107° of extension. The difficulty appeared to be in the region of the external lateral ligament in the joint line. Laboratory reports were all negative.

Operation.—Oct. 25, 1933, under general anesthesia, tourniquet was applied and the knee was exposed through a Kocher incision. The incision was carried down to the capsule. When the knee was extended from the flexed position, a large mass could be seen coming into prominence during extension and a snap could be heard. Opening the joint, the large mass was found to be a discoid meniscus about three times as thick and wide as normal. The cartilage disk was completely excised. Wound closed with silk. Physiotherapy was given to develop the quadriceps. On Sept. 19, 1935, the knee was well.

CASE 2.—M. T. (A178,328), female, aged 6 years, 7 months. Admitted, Jan. 29, 1934; discharged, March 8, 1934.

History.—There was a history of frequent attacks of pain in the left knee with swelling and tenderness on the lateral aspect of three months' duration. There was increased pain on motion and inability to extend the knee beyond 135°. There was no clicking and no history of trauma. The attacks occurred once to three

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times weekly and were of two or three days' duration. The attacks were sudden in onset and occurred while sitting and during active play.

Physical Examination.—Positive findings, confined to the left knee, showed $\frac{3}{4}$ inch atrophy of the thigh and $\frac{1}{2}$ inch atrophy of the calf. There was a definite mass over the head of the lateral condyle of the tibia. This mass could be pushed back into the joint on complete extension of the knee. Laboratory findings were negative.

Operation.—Under general anesthesia a tourniquet was applied and a Kocher incision made on the lateral aspect and carried down to the capsule. A definite mass could be felt on examination and this seemed to project over the joint. The joint was entered and the external meniscus was found to be thickened over its posterolateral border and in front of the external lateral ligament. It covered practically the whole articular surface of the outer tuberosity of the tibia. When this was dissected free, the knee could be completely extended without difficulty.

Postoperative Note.—There was mild effusion of the joint. Active motion was started on the fifth day. Wound healed by primary intention. Six months later there was normal motion in the knee without pain or recurrence of the previous symptoms.

CASE 3.—B. C. (A181,732), female, aged 2 years, 8 months. Admitted, March 22, 1937; discharged, April 13, 1937.

History.—Mother stated the child had always walked rather peculiarly, throwing one knee in and walking with flatfeet. The summer before, she was struck on left knee by her uncle while playing. The pain occurred only at that time, but the next day the knee was slightly swollen. She was taken to local doctor who found nothing unusual. X-rays were taken a week later but revealed no bony deformity. After a period of five weeks, during which time no improvement was noted, patient was referred to the outpatient department. When first seen there, the only clinical findings were those of slight limitation in extension and slight fullness on the lateral aspect of the left knee. X-rays then revealed no bony anomaly. The patient complained of pain when the knee was extended past the point of limitation. Child had continued to be active in all exercises. Child stated that one morning left knee snapped and after this she was able to extend the knee more than before and there was less swelling.

Physical Examination.—When the patient stood, there was definite genu valgum with both feet pronated, the left more than the right. Stood with left knee flexed and right knee in hyperextension. Very slight evidence of limp on walking. Examination of left knee showed no increased fluid. Palpable and observable fullness over femoral tibial fossa on the lateral aspect. The capsule in this area was slightly thickened. No movable or definite palpable mass was found, although joint line was not easily discernible. Tenderness over the tibial condyle laterally, just below the articular margin about 2 inches posterior to the lateral border of the patella and located about midway along the area of increased fullness. No evidence of any loose bodies. No locking. Lateral mobility slightly less than on the right. Rotation mobility about the same. Anterior and posterior mobility slightly decreased.

Operation.—Under general anesthesia, curved lateral incision was made. Knee joint opened and no increased fluid found. Lateral cartilage markedly enlarged and thickened and ran medially across the external tuberosity of the tibia, nearly covering the articular surface, and was attached at the medial aspect to the origin of the posterior limb of the cartilage. Narrow isthmus of synovial membrane connecting the anterior and posterior portions of the cartilage. Whole external semilunar cartilage removed. Wound closed.

Postoperative Note.—Good postoperative recovery. Stitches removed on the tenth day. Physiotherapy started on the thirteenth day.

Pathological Examination.—Examination of specimen removed at operation showed it to consist of fibrocartilage, highly collagenous tissue of the tendinous type and a moderate amount of fat. There was one large cystic area measuring 2 by 3 mm. in diameter in the junction between the fibrocartilage and tendon which was filled with pale blue-staining amorphous, mucoid-like material. The margins of the cyst were composed of flattened connective tissue cells and occasional foci of acute edema and degeneration of connective tissue. There were several small areas of similar cystic degeneration in the surrounding connective tissue and fibrocartilage. One of these was of special interest in that it apparently represented a very early lesion. This represented a small central cystic space containing a few macrophage-like cells surrounded by a fibrillar degenerating connective tissue in which there were a few young fibroblasts. *Diagnosis:* Cyst of the external semilunar cartilage with degeneration.

Ten months later, left knee showed complete extension and complete flexion. No fluid present. No instability. Quadriceps showed excellent tone and patient had a normal walking and running gait.



Fig. 1.—Joint opened, exposing cartilage.

CASE 4.—E. R., female, aged 31 years.

History.—At age of 4 or 5 years, she limped and was treated then with baking and massage. Had no particular discomfort at that time and noticed no pain about hips but became tired after walking any distance. Was unable to cross knees or get down from a high step without jumping. In 1934, three years previously, she was trying to put on overshoes and felt something give away on the inner aspect of the left knee. She was unable to straighten knee for several hours. Knee was treated with adhesive strapping. Had no trouble until January, 1937, when she had recurrence and knee became swollen. Treated with bandage but had another recurrence of original trouble three days later. This time it was on the outer side of the knee. Patient had three similar attacks. She was first seen by me in February, 1937. For two weeks she had been unable to get her knee perfectly straight.

Physical Examination.—The left knee lacked about 5° of complete extension. There was full range of motion in flexion. Slight excess of fluid in the joint. Definite marked local tenderness over the external semilunar cartilage. No tenderness elsewhere over knee. Forced internal rotation of the foot produced discomfort



Fig. 2.—Cartilage being dissected from the joint.



Fig. 3.—Cartilage practically cleared from the joint.

in the region of the external semilunar cartilage. Walked with a mild limp favoring the left knee. Walked with slight positive Trendelenburg. The hips were examined and showed some limitation of motion. The x-rays showed marked deformity of the heads of both femora suggestive of an old bilateral coxa plana. The x-rays of the knees were essentially negative, except for lipping as a result of hypertrophic arthritis.

Operation.—Under general anesthesia, curved Kocher incision was made over the lateral aspect. Capsule opened. Cystic mass was opened into superficially to the cartilage and the inner surface was finely granular. Synovial membrane was dissected free from the femur and tibia. Spur formation was plentiful and the reaction about the synovial membrane was consistent with hypertrophic arthritis and synovitis. The cartilage seemed larger than normal. The external lateral ligament was cut in order to expose the cartilage externally. The cartilage, which was a discoid affair, was removed. The articular cartilage over the lateral condyle was eroded over an area of about 3 cm. in diameter, exposing bare bone. The capsule was brought together and closed with fine silk; the iliotibial band was reunited and the subcutaneous fat and skin closed with interrupted sutures. Compression bandage and plaster splint applied.



Fig. 4.—Discoid cartilage. Irregularly shaped cartilage removed in Case 3. Disk not completed by cartilaginous tissue but by membranous tissue which does not show in specimen.

Postoperative Note.—Half of the sutures removed on eighth postoperative day and the rest on the tenth. Quadriceps settings started.

Pathologic Examination.—Cystic degeneration of the cartilage and discoid cartilage.

The patient was last seen in May, 1937, about three months after operation, and at that time had no fluid in knee. Could flex it to at least 10° or 15° beyond a right angle. Extension normal. Good gait.

Internal derangement of the knee in children, due to injuries of the semilunar cartilage, is extremely rare. Lesions of the external semilunar cartilage in adults are relatively rare. Lesions of the external semilunar cartilage in children are much more common than those of the internal semilunar cartilage. These lesions in children cannot be explained on a hypothesis of trauma. They can be explained, however, on an embryologic basis. The discoid cartilage lesion is due to a persistence of the embryonic form of the cartilage which is disk shaped and in most instances persists as a disk after birth. In some cases the cartilage is not in the form of a disk but is more or less shaped as shown in Fig. 4, with a membranous connection filling in the defect so that it resembles an incomplete disk. As growth goes on, these cartilages are prone to become thickened in their anterior, lateral, or posterior parts so that there is not enough room for them in the knee joint. As a result of this thickening, they are gradually pushed out of the joint in different positions of the knee if the thickened portion of the cartilage gets caught between the articular surfaces.



FIG. 5.—Shows tibial surface and cystic degeneration of specimen shown in Fig. 4.

In the adult and child cystic degeneration may take place in a portion of the cartilage.

Symptoms.—In some instances symptoms of trigger knee may be noticed by the parents, but the symptoms and signs are more apparent after weight-bearing has begun and the muscles and ligaments have tightened physiologically.

These children complain of attacks of sudden pain in the knee which may appear at any time when the cartilage catches on bending or extending the knee. There is usually a limp present, and there may be swelling of the knee.

Examination.—Examination shows atrophy of the calf and thigh muscles, and fluid may be present in the joint. The joint may be locked in flexion or rarely in extension. On palpating the extended knee, a small tumor-like mass is felt over the lateral aspect of the joint in the region of the lateral ligament. This mass usually disappears on flexion and reappears on extension with a definite snap and a jerking sensation. If it is large, the snap may occur both on flexion and extension.

Discoid Cartilage.—Discoid cartilage is a persistent embryonic cartilage which varies in shape and thickness. It may completely cover the external articular surface of the head of the tibia or it may cover only a part of the surface. In one case there was a thin membrane covering that portion of the articular surfaces not covered by the discoid cartilage. If the cartilage is thicker than the normal external semilunar, there will be symptoms of an internal derangement of the knee. It is possible that a discoid cartilage may be present without symptoms.

Treatment.—The treatment for discoid cartilage giving rise to symptoms is complete extirpation of the cartilage as soon as the diagnosis is made. In cases complicated by cysts of the cartilage, the cartilage must be removed. If this is not done, the mechanical irritation of a cartilage, which is becoming enlarged from the cyst formation, is likely to injure the articular surfaces and produce arthritic changes.

REFERENCE

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PANTALAR ARTHRODESIS IN POLIOMYELITIS*

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BY THE TERM pantalar arthrodesis is meant the surgical fusion of the tibiotalar, talonavicular, talocalcaneal, and calcaneocuboid articulations; in other words, the surgical arthrodesis of the ankle and subtalar joints.

The purpose of this paper is to give briefly the indications, the technique, and the results of the operation as performed for anterior poliomyelitis.

The procedure was originally carried out only in cases of tuberculosis and the first pantalar arthrodesis performed at the New York Orthopaedic Dispensary and Hospital was in 1920, for tuberculosis involving the ankle and subtalar joints. Additional cases were operated upon in the succeeding years and, after the observation that such an extensive arthrodesis did not materially impair the patient's gait, the procedure was deemed applicable to other conditions.

In 1931 the operation was performed for deformity and instability of the foot due to poliomyelitis, and by Jan. 1, 1937, eighty-two such patients had been operated upon.

The reason for doing pantalar arthrodeses in poliomyelitis is to stabilize the foot in good lateral position and to improve an awkward gait in patients who have the deformities of calcaneus or equinus, combined with lateral instability of the foot. An additional reason, in cases with similar deformities, is the stabilization of the knee when that joint has been made unstable by paralysis of the quadriceps muscles. Braces which have been worn for instability often may be discarded following operation, and walking becomes easier, smoother, and less fatiguing.

It is felt that the operation should be done in two stages. Five patients did have the combined operation performed in one stage, but this is not recommended, because of the length of operating time and the difficulty in obtaining correction of all deformities simultaneously.

It is considered best to do the subtalar arthrodesis before the ankle fusion. If the ankle is fused first, it is very difficult to maintain the right degree of equinus and correct the other deformities. On the other hand, if the subtalar arthrodesis is done first, then all attention can be concentrated upon putting the foot at the desired degree of equinus, the importance of which will be brought out later.

The surgical technique recommended for the subtalar arthrodesis is that described by Hoke, which is well known without further description. For fusing the ankle, the multiple chip method is recommended.

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about $\frac{3}{4}$ inch in height and produces an equinus of about 5° . The ordinary heel of a woman's shoe is about $2\frac{1}{4}$ inches in height and produces an equinus of the foot of about 15° . Therefore, one can estimate the degree of equinus in which a foot should be placed by determining the height of the heel the patient ordinarily wears, allowing 5° of equinus for each $\frac{3}{4}$ inch of heel height.

For these reasons, it is obvious that one must determine before operation the type of heel the patient most commonly will wear. It is difficult to state the exact degree of equinus which will be applicable to all patients. However, from experience, approximately 10° of equinus has been found to be most satisfactory, because the patients who obtained an excellent result were those with a permanent equinus ranging from 99 to 103° . Other patients with a little less or a little more equinus than this obtained good results by the simple expedient of small adjustments in the height of the heel.

It is very difficult to obtain the proper degree of equinus at the time of operation, because during application of the cast following operation estimation of equinus has to be made by the surgeon's judgment. This is extremely variable, even with the same surgeon. It is absolutely necessary, therefore, to check the position of the foot within a few days after operation with lateral roentgenograms, and whenever the equinus is too great or too little the plaster must be wedged. In this series, wedging was necessary in 21 per cent of the cases.

Estimation of equinus by roentgenograms is made by two lines, one drawn down the midshaft of the tibia and the other drawn from the base of the head of the first metatarsal bone to the base of the calcaneum. The angle at the point subtended by these two lines is the degree of equinus. Errors in determining the actual equinus of the foot will be made if the amount of anteroposterior motion at the anterior tarsal joints is not taken into account. For example, let us assume that there are 10° of anteroposterior forefoot motion extending from 100° dorsiflexion to 90° dorsiflexion. Should the forefoot be drawn down, when the cast is applied after operation, the x-ray measurement would reveal the foot to be at 100° . But when the patient stands on the foot without plaster, the forefoot will move upward 10° , placing the foot in an actual position of only 90° dorsiflexion, which is insufficient for a good gait. This very thing occurred in 6 per cent of the patients in this series.

Therefore, in order to obtain an accurate roentgenographic reading of equinus, the entire foot first must be placed in marked equinus and then the forefoot must be brought up until the desired degree of equinus is obtained.

About 35 per cent of the patients required some sort of heel or sole lifts. These varied between raising the heel $\frac{1}{4}$ inch in height to promote a smoother gait and raising the heel 3 inches and the sole 2 inches to compensate for 3 inches shortening of the leg.

The joint is approached by a five-inch anterior incision in the sagittal plane, dividing the skin and subcutaneous tissues and, more deeply, the transverse crural and cruciate ligaments. The extensor hallucis longus and anterior tibial tendons, together with the dorsalis pedis artery, vein, and deep peroneal nerve, are retracted medially, and the extensor digitorum longus tendons laterally. The anterior lateral malleolar artery and vein are divided and ligated. The periosteum over the tibial diaphysis is incised, but one should avoid stripping the periosteum over the epiphyseal cartilage.

The articular cartilage is then entirely removed together with bone sufficient to correct the deformity or to put the foot in the desired position. With a curved osteotome, opposing surfaces are roughened so as to make a soft bed of cancellous bone. Using the same incision, bone is gouged from the lower tibial diaphysis well above the epiphyseal cartilage and small chips are wedged into the joint, particularly between the talus and malleoli. This is important because it eliminates the space created by removing the cartilage and insures firm contact of bone surfaces. A few bone chips are placed over the anterior aspect of the joint.

The capsule, periosteum, and other deep tissues are reunited with interrupted catgut sutures and the skin with silk sutures.

These operations, of course, cannot be performed until the bones of the foot are sufficiently developed. Such development varies and must be judged by roentgenograms. Usually the patient has to be at least 8 years old before the subtalar arthrodesis can be performed. The ankle fusion can be done any time after six weeks from the date of the subtalar arthrodesis. When the distal epiphyseal cartilage of the tibia is still present, care must be taken not to injure it.

The most important single factor in pantalar arthrodesis is the position of the foot following operation. It is assumed without discussion that following a subtalar arthrodesis, the foot should not be immobilized in varus or in too much valgus.

The entire success of the subsequent ankle fusion depends upon immobilizing the foot in the proper degree of equinus. Too little equinus results in a stiff, peg-leg gait. The other extreme of too much equinus produces a halting gait, in which the foot is kept in front of the body and walking is accomplished by taking short steps, pushing the arthrodesed foot ahead, and bringing the opposite foot up from the rear. However, when the proper degree of equinus is present, the patient walks with no perceptible limp, providing there is no extraneous deformity to affect the gait.

Normal individuals were studied to note the relationship between the height of the heel of the shoe and the degree of equinus of the foot. This was done by taking lateral roentgenograms of the foot while the individual was wearing a shoe and measuring the degree of equinus of the foot and the height of the heel. The ordinary heel of a man's shoe is

PATHOLOGY AND OPERATIVE CORRECTION OF FINGER DEFORMITIES DUE TO INJURIES AND CONTRACTURES OF THE EXTENSOR DIGITORUM TENDON

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THE operative correction of certain soft tissue deformities of the fingers presents difficulties and produces unsatisfactory results even when the most skilful technique is applied. This is true not only of cases in which the flexor surface structures are involved, but also, and perhaps, more frequently, when the injury is found on the extensor aspect of the digit.

The extensor digitorum communis tendon, as found over the dorsum of the fingers, was dissected by many anatomists. There was a controversy which lasted for many years about the minute structure and the function of the tendon. The gradual accumulation of knowledge on the physiology and anatomy of the hand is a very interesting subject but will not be dealt with in the present study.

It is my intention to present the anatomy of the extensor tendon in some detail, as this will permit better understanding of the four deformities which will be analyzed in this work; it will also help to grasp the principles of treatment for the correction of these deformities.

The description of the extensor tendon and its dependencies over the dorsum of the fingers is based on a personal investigation and, especially, on a recent study of these structures by R. Montant and A. Baumann of the University of Geneva, Switzerland. The two authors made serial cuts of fetal and adult fingers which were examined microscopically and then reconstructed on a larger scale. They also made clinical observations and dissections. This permitted the authors to establish more accurately the relationship between the extensor tendon, the interossei, and the lumbricals.

An anatomic investigation concerning muscle action can never be completed unless various methods of approach are used, such as electrical stimulation, clinical investigation on normal and abnormal muscles, and experiments on cadavera. The description of the physiology and anatomy of the extensor as given here is a result of such a study made by me and also based on combined efforts of numerous investigators who, beginning with Duchenne of Boulogne, laid the foundation of the exact physiology of the muscles of the body.

ANATOMY OF THE EXTENSOR APPARATUS OF THE FINGERS

The following is a description of the extensor tendon as given by French anatomists. The tendon of the extensor digitorum communis,

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Obviously, increasing the thickness of the sole or heel materially aids a limp that is due to a short extremity, but it has no effect on a limp or lurch due to poor or absent abductor muscles.

Heel lifts also are employed to give longer strides, to allow the heel to touch the floor, and to improve the gait. This does not hold, however, in cases of ankle fusion to stabilize the knee, because here too high a heel may cause the knee to give way. Whenever sufficient equinus has not been obtained to stabilize the knee, it is best to employ an anterior heel; that is, a thick metatarsal bar across the sole of the shoe. Thus, when the foot is bearing weight, the tibia is held posteriorly, forcing the knee into extension.

When stability of the knee is not a problem and one has obtained too much equinus, the heel may be raised accordingly. Such building-up of the heel will work very well for as much as 20° equinus, provided good forefoot motion is present.

Revision of either the ankle fusion or the subtalar arthrodesis may be necessary for pseudarthrosis, varus, valgus, and improper equinus. Eleven of the eighty-two patients (13 per cent) required secondary operations. Five revisions were necessary for pseudarthrosis, three of which occurred at the ankle joint and two of which occurred at one or more of the subtalar joints. Two subtalar arthrodeses were revised because of varus. In one instance it was necessary to revise a subtalar arthrodesis for excessive valgus. Three revisions were done, two at the ankle and one at the subtalar joints, for improper equinus.

The results of pantalar arthrodesis in the eighty-two patients in this study were based upon an average follow-up period of three years. Failures occurred in 3 per cent. In each case the knee was not stabilized. Fair results occurred in 17 per cent. One of these patients suffered mild pain; another had edema of the leg; and the remainder were improved, but they did not have as good a gait as they might have had because of improper equinus. Good results occurred in 80 per cent. These patients had a good gait, suffered no pain, and were pleased with the operative procedure.

In conclusion, it can be said that pantalar arthrodesis is a worth-while procedure, and, when carefully performed in properly selected patients, can be relied upon to give a uniformly satisfactory result.

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tendon continues its course further, running parallel to the lateral band and finally inserts itself, together with the lateral band, into the base of the distal phalanx as described above. The tendon of the lumbrical joins the interosseus and runs parallel to the interosseus and outside of it and the lateral band of the extensor tendon. The lumbricals are situated on the radial side of the tendons of the interossei.

Thus, the lateral bands which are observed on gross anatomical examination really consist of three distinct structures on the radial side of the fingers (the lateral bands of the extensor tendon, the interosseus and the lumbricals) and two on the ulnar side; namely, the lateral band of the extensor tendon and the interosseus (Fig. 1). It was found that the lumbrical unites with the interosseus distally to the interosseus expansion.

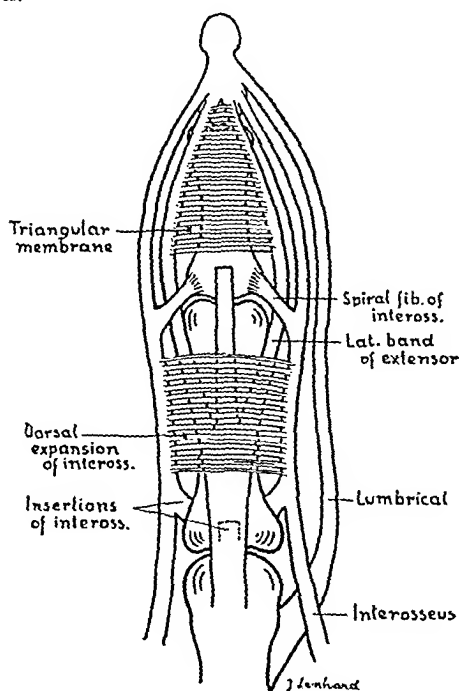


Fig. 1.

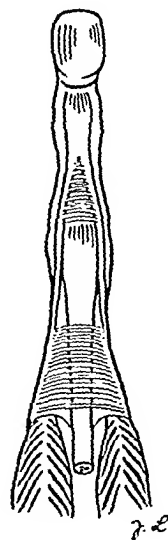


Fig. 2.

Fig. 1.—Schematic representation of the dorsal aspect of the extensor tendon with the tendons of the interosseus and lumbrical artificially separated. At the base of the first phalanx the insertion of the median band of the extensor tendon is shown in a broken line. In hyperextension of proximal phalanx the entire traction force of the extensor tendon is spent at this insertion.

Fig. 2.—A semischematic illustration of the triangular membrane on the dorsum of the middle phalanx.

Montant and Baumann called special attention to a structure which apparently is very important. They describe a very resistant, although very thin, membrane which they call the triangular membrane. This membrane is located at the dorsum of the middle phalanx between the lateral bands of the extensor (Figs. 1 and 2). This membrane prevents the lateral band from sliding toward the lateral sides of the finger when

arriving at the head of the corresponding metacarpal, maintains its course toward the base of the first phalanx; it bridges the metacarpophalangeal joint, forming the posterior capsule, and sends a strong insertion to the base of the first phalanx. The course of the tendon is continued over the insertion distally until it arrives at a point above the middle of the first phalanx where it divides into three distinct bands, one middle and two laterals (in relation to the axis of the finger). The middle band continues the course of the extensor tendon, bridges over the proximal interphalangeal joint, forming the posterior capsule for this joint, and inserts itself into the base of the middle phalanx. At this point the middle band terminates. The lateral bands run over the dorsolateral sides of the distal part of the first phalanx, then over the proximal part of the middle phalanx, and then gradually become more dorsal; the two bands unite at about the distal third of the middle phalanx. From here on this united band bridges the distal interphalangeal joint, forming again the posterior capsule, and finally inserts into the base of the distal phalanx. This terminal insertion sends up strands of fibers into the periosteum of the rest of the distal phalanx toward the matrix of the nail and to the skin. The extensor tendon, as mentioned above, forms the posterior capsule of the metacarpophalangeal, the proximal interphalangeal, and the distal interphalangeal joints. The terminal insertion of the extensor tendon enters into a complicated relation with the interossei and the lumbricals. This relation is very important, as only the combined action of all these muscles, as it is well known, contributes to a normal function of the fingers.

The interossei, arriving at the space between the metacarpal heads, form a flat tendon directed anteroposteriorly, which continues its course over the dorsolateral aspect of the capsule of the metacarpophalangeal joint; at the base of the proximal phalanx it divides into two parts: an anterior and posterior. The anterior forms a strong insertion to the lateral tubercle of the base of the proximal phalanx. The posterior continues distally, parallel to the lateral band of the extensor tendon and outside of it in relation to the long axis of the finger. Just above the metacarpophalangeal joint the interosseus tendon sends a flat membranous structure toward and over the middle band of the extensor tendon on the dorsum of the proximal phalanx. This membranous structure meets a similar structure formed by the interosseus on the other side of the finger and which covers the extensor tendon. It is called the expansion of the interossei and plays an important role in flexion of the proximal phalanx. The rest of the interosseus tendon continues its course parallel to the lateral band of the extensor to the proximal interphalangeal joint; at this point it sends a few spiral fibers dorsal to the lateral band of the extensor tendon. The spiral bands cross obliquely the lateral bands of the extensor and become inserted to the median band at the base of the proximal phalanx. The interosseus

for the inner lumbricals. It should be mentioned, however, that the interossei may also be supplied by branches of the radial as described by Rauber.

PHYSIOLOGY OF EXTENSOR APPARATUS

The present conception of the action of the extensor and the combined action of the interossei and lumbricals differs from the original description as given by Duchenne. Montant and Baumann summarize it in the following manner. When the finger is in full flexion, the extension of

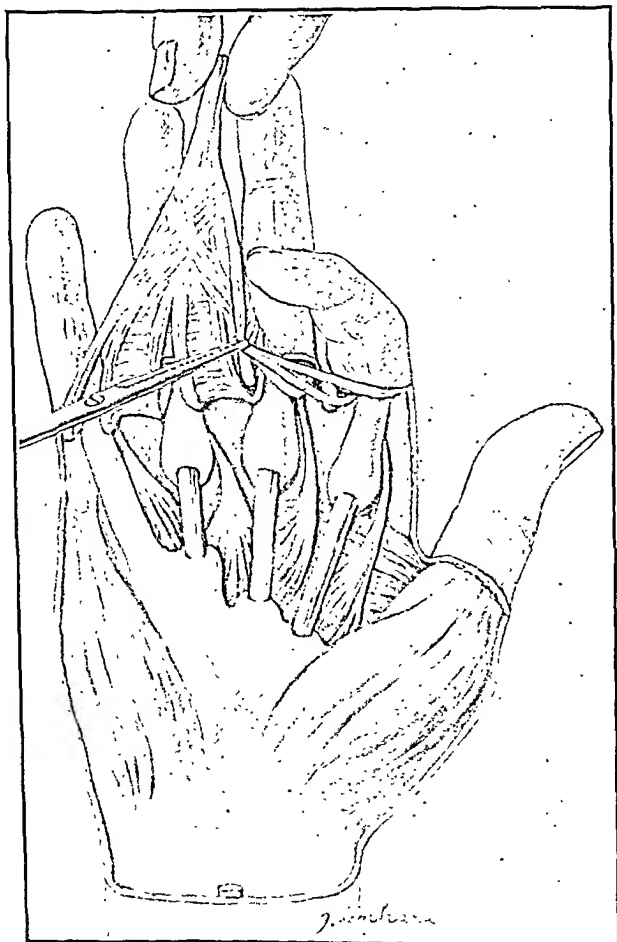


FIG. 1.—The palmar fascia separated from the underlying structures and lifted up. Experimental traction on the under surface of the longitudinal pretendinous band shows flexion of the proximal and middle phalanges.

the finger beginning in the distal phalanx is due to a simultaneous traction of the extensor and the interossei-lumbrical with a preponderance of the extensor tendon action. This preponderance continues up to the moment when the finger reaches the horizontal plane, when the action of the extensor is equal to the action of the interossei-lumbrical. When

flexion is produced at the proximal interphalangeal joint. The lateral bands are connected by fibers, perpendicular to the long axis of the finger, to the osteoperiosteal tunnel of the flexor tendons of the finger. These perpendicular fibers pull the lateral bands toward the volar surface. The balance between the intact triangular membrane and the perpendicular fibers maintains the normal position of the lateral bands over the dorsum of the middle phalanx. The description of the extensor

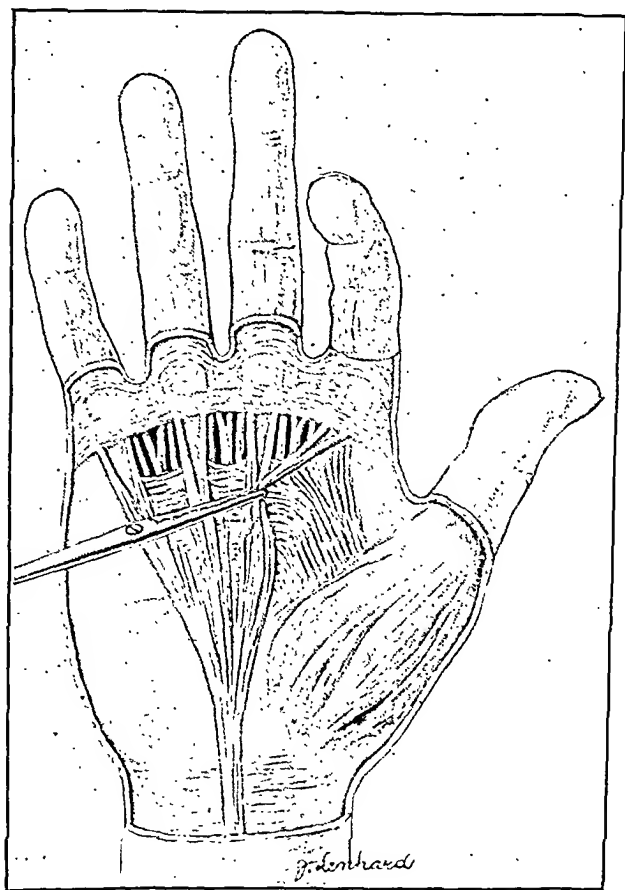


Fig. .3—Palmar fascia after removal of skin. Experimental traction on the longitudinal pretendinous band of the index shows flexion of the proximal and middle phalanges.

apparatus including the interossei and lumbricals, as given above, is considered to be the more generally encountered. It should be emphasized, however, that numerous variations affecting the volume of the interossei and lumbricals as well as the shape, insertion and nerve supply may be seen. It is well established that the extensor digitorum is supplied by the radial nerve, the interossei by the deep branch of the ulnar, and the lumbricals by the median for the two outer lumbricals and by the ulnar

tendinous band when the palmar aponeurosis is left intact (Fig. 3) and when the palmar aponeurosis is separated from the underlying tissues (Fig. 4) as reported in a previous communication. In Dupuytren's contracture the flexion contracture is usually pronounced at the proximal interphalangeal joint (Fig. 5). This marked flexion is apparently due to a contracture of the digital expansions of the palmar aponeurosis which is attached to the lateral bands of the extensor tendon. In considering the operative correction of Dupuytren's contracture, it is important, therefore, to remove the longitudinal pretendinous bands of the palmar aponeurosis from the palm of the hand and from the fingers and, especially, to separate these aponeurotic expansions from the lateral bands of the extensor tendon.

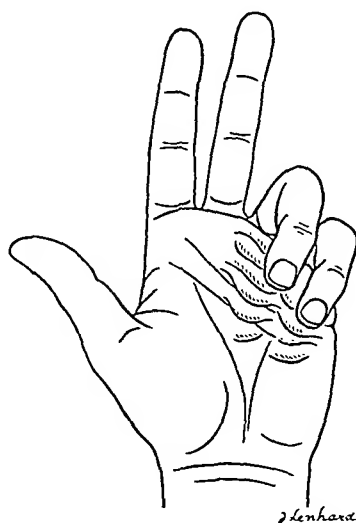


Fig. 5.—Dupuytren's contracture.

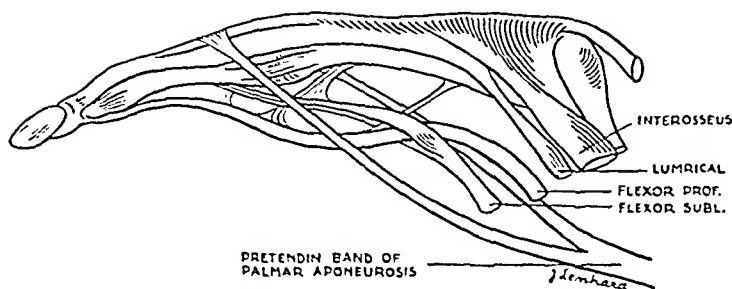


Fig. 6.—Digital expansions of the longitudinal pretendinous band of palmar aponeurosis connected with the lateral bands of the extensor digitorum tendon, as found by personal investigation and schematically represented. (Illustration partly redrawn from Toldt's *Atlas of Anatomy*, Berlin, 1921, Vrach Publishing Co.)

Mallet Finger or Baseball Finger.—A study of the so-called baseball finger convinced me that in the majority of cases the deformity is not due to an avulsion of the insertion of the extensor tendon from the base

the proximal phalanx hyperextends, the action of the extensor on the two distal phalanges is not exerted any more, as it is completely spent at the insertion of the extensor tendon to the base of the proximal phalanx. The extension of the two distal phalanges then is due entirely to the interossei-lumbrical combination.

When an analysis is made of injuries to the extensor and interossei, the variations in nerve supply must be kept in mind and also the newest conceptions of muscle action. It should not be forgotten that the extensor communis has also an abductor-adductor action on the fingers. Most of all, it must be remembered that on a cadaver, as well as on surgical exposure of the extensor communis tendon, traction of the tendon, when the finger is completely flexed, will produce a gradual extension, beginning with the distal interphalangeal joint, then the proximal interphalangeal, and then the metacarpophalangeal joints. When the metacarpophalangeal joint is hyperextended by the extensor communis, the two distal phalanges flex because the extensor communis spends all its force at the base of the proximal phalanx; the interossei-lumbrical then completes the extension of the two distal phalanges. When the metacarpophalangeal joint is flexed by the combined action of the interossei-lumbrical, the two distal phalanges can be easily extended by the extensor communis which does not spend its traction force on the base of the proximal phalanx.

In partial ulnar paralysis, where the proximal phalanx is kept hyperextended at the metacarpophalangeal joint and the two distal phalanges are kept flexed, the explanation of this deformity becomes simple if it is considered that the extensor tendon cannot exert any action on the two distal phalanges when it spends all its traction force on the base of the proximal phalanx and the interossei and lumbricals are inactive on account of the ulnar nerve paralysis.

CERTAIN PATHOLOGIC CONDITIONS OF THE EXTENSOR APPARATUS

Dupuytren's Contracture.—In a recent study made by me on the relation between the palmar aponeurosis and Dupuytren's contracture, it was found that anatomically the flexion of the fingers is due to the contracture of the longitudinal pretendinous bands of the palmar aponeurosis. The longitudinal pretendinous extensions of the palmar aponeurosis, as shown by many authors, extend into the fingers between the skin and the osteoperiosteal tunnels of the flexor tendons and insert to the lateral sides of the phalanges. Investigating the insertion of the longitudinal digital extensions, I found that they insert themselves not into the periosteum of the phalanges but are connected with the lateral bands of the extensor apparatus of the finger distal to the proximal interphalangeal joint. This is schematically shown in Fig. 6.

Figs. 3 and 4 show the palmar aponeurosis with its digital expansions and the effect produced by traction applied to a longitudinal pre-

The distal phalanx comes up in extension as soon as the torn lateral bands are sutured together. The finger is kept on a splint for three weeks, the hand being kept in neutral position and the metacarpophalangeal joint in slight flexion.

It is not denied that occasionally chip fractures of the base of the distal phalanx may occur, but these are due to a different type of injury and may heal on a hyperextension splint. It is advisable to x-ray the finger before the operative procedure is undertaken.

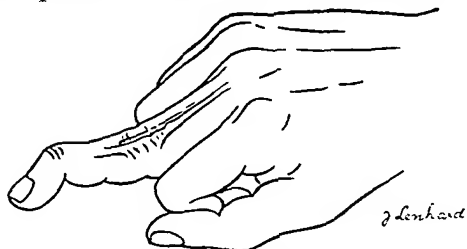


Fig. 10.—Flexion deformity of the distal phalanx combined with extension of the proximal interphalangeal joint.

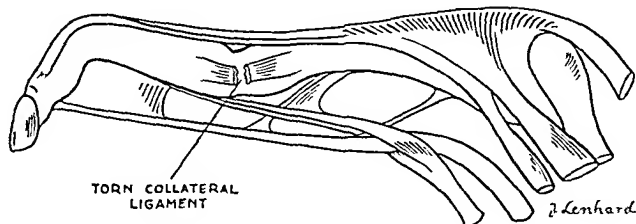


Fig. 11.—Pathology of the above-described deformity, consisting in a tear of the lateral ligaments of the proximal interphalangeal joint with a sliding toward the dorsum of the finger of the lateral bands of the extensor tendon.

Hyperextension of the Proximal Interphalangeal Joint.—

The fingers sometimes present a special deformity which follows an impact to the volar surface of the distal two phalanges. There is immediate pain over the volar surface of the proximal interphalangeal joint with swelling. Subsequently the patient develops an inability to flex the finger at the proximal interphalangeal joint after full extension of the fingers. A typical case was previously described as follows: The injured finger could be passively hyperextended to about 205° at the proximal interphalangeal joint. This finger could be actively hyperextended to about 190° at the same point. After full voluntary hyperextension of the finger, an attempt to flex all the fingers (to make a fist) resulted in normal flexion in all of the fingers except the middle one, which remained hyperextended at the proximal interphalangeal joint. The distal phalanx of this finger was the only one that flexed almost to 100° . Two distinct lateral cords of the collateral extensor tendon of the finger could be seen to be very tense under the skin of the dorsal aspect of the finger. No matter how hard the patient tried to flex this finger, it would remain hyperextended at the proximal interphalangeal joint. (Fig. 10.)

of the distal phalanx. An examination of several of these cases immediately after the accident revealed that the area of acute pain was located over the middle of the dorsum of the middle phalanx. This area appeared slightly depressed as if the underlying structures had slipped away between the skin and the phalanx; a slight bulge was found at the distal end of the dorsum of the middle phalanx. These findings suggested the possibility of a different location of the tear. Indeed, on operation it was found that the tear of the extensor tendon was situated not at the base of the distal phalanx but over the middle or distal third of the dorsum of the middle phalanx, involving the two lateral bands and, at times, the triangular membrane, as schematically shown in Fig. 8. To repair this tear a procedure which is illustrated in Fig. 9 was used. The injured area is exposed through a U-incision with a distal base. The incision begins at the lateral side of the finger in line with the distal

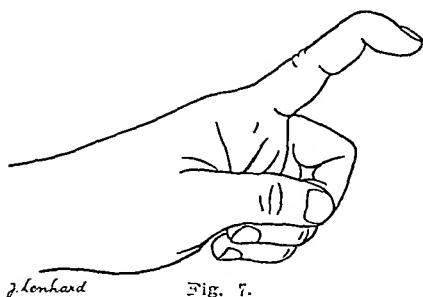


Fig. 7.

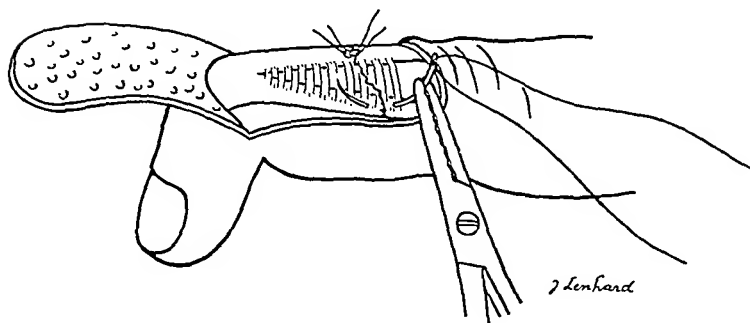


Fig. 9.

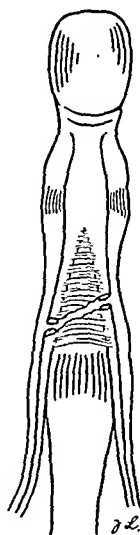


Fig. 8.

Fig. 7.—Baseball finger or mallet finger. Impossibility to extend the distal phalanx.

Fig. 8.—Pathology of baseball finger, consisting in a more-or-less oblique tear of the lateral bands of the extensor tendon and the triangular membrane between them.

Fig. 9.—Operative correction of mallet finger deformity. Description in text.

interphalangeal joint, runs parallel to the long axis of the finger at the junction of the lateral and dorsal lines of the finger. It rounds slightly distally to the proximal interphalangeal joint and comes out symmetrically on the other lateral side of the finger. The exposure usually shows the lateral bands and the above described triangular membrane, torn transversely over the dorsum of the middle phalanx. The repair consists in suturing the torn lateral bands as shown in the illustration.

the injured finger remains flexed and the more the patient tries to extend it the more flexion is produced at the proximal interphalangeal joint. The distal phalanx hyperextends. This deformity is usually produced by a direct force applied to the dorsum of the middle phalanx or by a

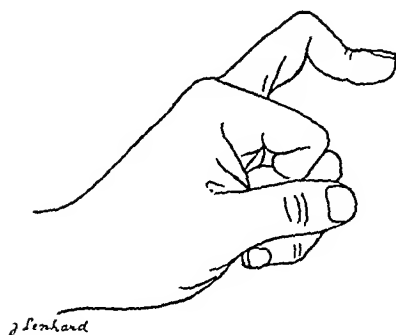


Fig. 13.

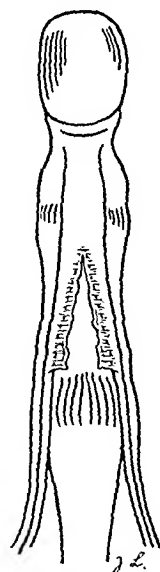


Fig. 14.

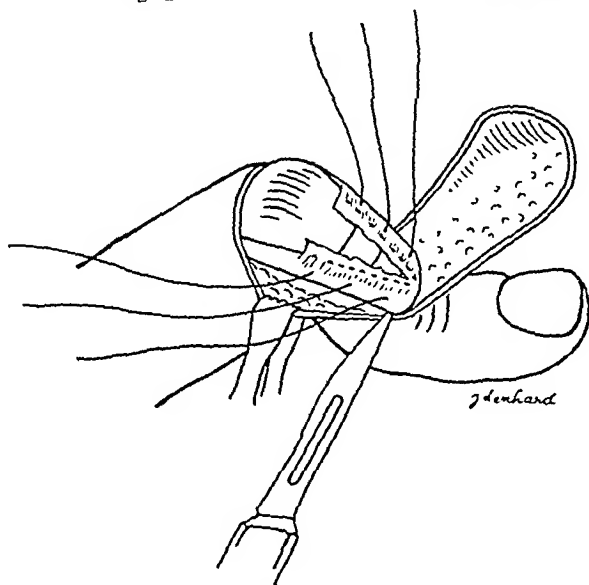


Fig. 15.

Fig. 13.—Buttonhole rupture of the extensor tendon with a typical flexion of the proximal interphalangeal joint and extension of the distal phalanx.

Fig. 14.—Pathology of the buttonhole rupture as shown by R. Montant and A. Baumann, consisting in a tear of the triangular membrane.

Fig. 15.—Operative correction of the buttonhole deformity as proposed by R. Montant and A. Baumann, consisting in a suture of the lateral bands over the dorsum of the middle phalanx with the author's addition of a longitudinal separation of the dislocated lateral bands from the lateral sides of the phalanx.

A personal investigation previously reported by me showed that this deformity was due to a tear of the lateral ligaments of the proximal interphalangeal joint and could be easily reproduced on a cadaver. The lateral bands of the extensor tendon, after an injury of this sort, are gradually retracted toward the dorsum of the finger. The sliding of these bands from their normal dorsolateral position into a dorsal position changes their function. When an extension of the finger is produced, the transverse axis of the proximal interphalangeal joint slips below the normal traction of the lateral extensor bands and a subsequent effort to flexion produces a hyperextension at the interphalangeal joint. Fig. 11 illustrates the pathology of this deformity.

The operative correction of this deformity can be obtained by a small lateral incision over the proximal interphalangeal joint on each side of the finger (Fig. 12). It consists in a repair of the torn collateral ligaments of the interphalangeal joint in cases where the collateral ligament can be easily recognized or in a reefing of the lateral volar part of the

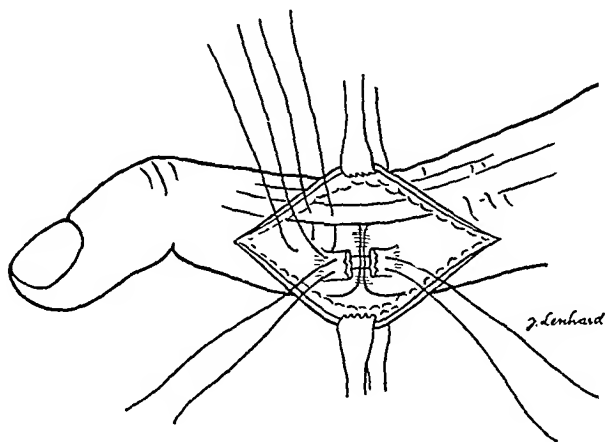


Fig. 12.—Operative correction of this deformity consisting in reparation of the lateral ligaments as proposed by the author previously, with an additional suture of the lateral bands to the lateral periosteum of the middle phalanx. This is done through a short incision over each side of the finger.

capsule of the interphalangeal joint in cases where the collateral ligament cannot be recognized. It is also necessary to bring the lateral bands of the extensor tendon from the dorsum of the finger to the lateral sides and suture them to the periosteums of the middle phalanx. After the closure of the wound, the finger is placed in slight flexion of all the joints and the hand in neutral position for three weeks.

Buttonhole Tear of the Extensor Apparatus.—This produces a flexion deformity of the proximal interphalangeal joint and an extension of the distal phalanx at the distal interphalangeal joint (Fig. 13). This deformity is best demonstrated when the patient, having all his fingers flexed, makes an effort to extend the fingers. The fingers will come up flexed, except the injured finger. The middle phalanx of

- Kaplan, E. B.: Extension Deformities of the Proximal Interphalangeal Joints of the Fingers, *J. Bone & Joint Surg.* 18: 781, 1936; with correction 19: 1144, 1937.
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forced hyperflexion of the proximal interphalangeal joint while the finger is held in extension.

The mechanism of this deformity was described in detail by Montant and Baumann. They found that the deformity is due primarily to a longitudinal rupture of the triangular membrane which they described in detail and which unites the complex lateral bands of the extensor tendon over the dorsum of the middle phalanx. The lateral bands are held over the dorsum of the middle phalanx by this membrane which does not let them slip laterally under the action of the above mentioned connection of these bands with the osteoperiosteal tunnel of the flexor surface of the finger. The rupture of the triangular membrane permits a luxation of the lateral bands toward the volar surface of the fingers; the proximal interphalangeal joint becomes pinched between the lateral bands. The effort to extend a finger with such an injury produces traction on the dislocated lateral bands below the transverse axis of the proximal interphalangeal joint and thus produces flexion instead of the normal extension. (Fig. 14.)

The correction of this deformity can be obtained by suturing the lateral bands together over the dorsum of the middle phalanx, from the apex of the triangular membrane to a line just distal to the proximal interphalangeal joint as proposed by Montant and Baumann. Unfortunately the approximation of these two bands in old cases may prove to be a very difficult task. The lateral bands retract toward the volar surface and may adhere to the periosteum in their abnormal position. I found it, therefore, necessary to separate the lateral bands longitudinally from the periosteum as it is indicated in Fig. 15. A U-incision with a distal base as used for the deformity described before is advised; it gives the best exposure of the dorsum and the lateral sides of the phalanx and facilitates the operative procedure. After the operation the finger is kept in extension on a splint for three weeks, the hand being kept in neutral position and the metacarpophalangeal joint in slight flexion.

SUMMARY

The anatomy and physiology of the extensor apparatus of the fingers is presented. Four deformities of the fingers are described, showing their pathology and the operative correction.

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and its deficiency may cause the development of bone changes, especially rickets. The role of viosterol, calcium, and bile in the management of the hemorrhagic tendency in jaundice has been stressed by McNealy, Shapiro, and Melnick.²⁷ Osborne, Mendel, and Ferry²⁸ were first to call attention to the occurrence of urinary calculi in rats fed on diets deficient in fat-soluble vitamins, but the exact mechanism of stone formation under these conditions was not clear. More recently the work of Steiner, Zuger, and Kramer²⁹ has done much to clarify the part played by the changes in the lining epithelium of the urinary tract. Higgins³⁰ reports a marked decrease in the number of recurrences of renal calculi when a high vitamin A diet was instituted.

Most of our gastrointestinal diets contain adequate amounts of milk and cream so that a deficiency of vitamins A and D is not probable. The water-soluble vitamins B and C are more important in this discussion.

Vitamin B occurs most abundantly in yeast. Other sources are meat, glandular organs, and vegetables. There are apparently at least two factors in this vitamin: B₁ the antiberiberi factor; and B₂ (G), the antipellagra factor. Nerve lesions are common in deficiency states due to either of these factors. Deficiency of B₂ also produces mental changes, skin desquamation, and gastrointestinal disturbances. McCarrison³ states that vitamin B deficiency causes gastrointestinal changes similar to colitis. Common symptoms are anorexia, weakness, vague pains, indigestion, and hypotonicity of the bowel. McCarrison states further that many of the gastrointestinal disorders of today are due to deficient and ill-balanced diets. He suggests that the health of the alimentary canal is dependent on vitamins B and C. Ravdin and Frazier³¹ suggest that vitamin B complex be used to improve carbohydrate metabolism in the preoperative management of hyperthyroidism.

Vitamin C occurs in most fresh fruits and vegetables, our best sources being orange juice, tomato juice, and grapefruit juice. Deficiency of vitamin C causes scurvy. Clinically scurvy is characterized by hemorrhage from the skin (ecchymosis, typically perifollicular), mucous membranes, muscles, nerve sheaths, and periosteum. These hemorrhagic manifestations of vitamin C deficiency are due to an impairment of intercellular substance supporting the blood vessels. The endothelium of the capillaries is unable to form normal cement substance allowing diapedesis of red blood cells and loss of serum. This is particularly true of the blood channels supplying the pilosebaceous apparatus.⁴ Bone changes also occur in scurvy due to a disturbance of the ossification rather than the calcification, as in rickets. Scorbatic patients also show a secondary anemia due to disturbance of hematopoiesis.

Methods are now available for the measurement of the state of vitamin C nutrition. In our determinations we have followed the method of Farmer and Abt.⁵ Clinical levels of vitamin C nutrition have been

DIETARY DEFICIENCIES IN SURGICAL PATIENTS

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DIETS commonly prescribed for dysfunction of the gastrointestinal tract are often unnecessarily rigid and in many instances actually are deficient in vitamins, minerals, and caloric value. Patients who have benefited by dietary measures are prone to rationalize that if dieting helps more dieting must certainly have added virtue. They may remain on stricter diets than physicians have intended and persist in these over periods ranging from weeks to years. If, as so often happens, these patients are plunged suddenly into a crisis by an acute exacerbation of their previous affliction or one related to it, they may exhibit alarming states of nutritional deficiencies. Vitamins are dissipated more rapidly when metabolism is increased or temperature elevated. A knowledge of vitamins and their relation to health and well-being is no longer confined to the research worker or faddist. The general public is becoming diet conscious and the restrictions imposed or elected by patients must be anticipated by both internists and surgeons if grave deficiency states are not overlooked to the great detriment of the patient. Operative risks may be lessened and postoperative convalescence greatly facilitated if optimum vitamin states are maintained. A brief review of the better known vitamins, their sources and uses, may be helpful at this point.

Fat-soluble vitamin A occurs in butter fat, egg yolk, animal fat, and many fish oils. It has been shown that carotene¹ of vegetables is the precursor of vitamin A, and it is thought that it is converted into vitamin A in the liver by the action of the enzymes. Deficiency of vitamin A produces a keratinization of epithelial surfaces. Columnar epithelium is changed to stratified epithelium. Cornification takes place with blocking of ducts of the glands present in the epithelial surface. Cyst formation and ulceration may follow. Vitamin A deficiency produces these changes in all epithelial surfaces. In the eye they give rise to xerosis, ulceration of lacrimal glands, and night blindness. Similar changes occur in the skin, respiratory tract, gastrointestinal tract, and the genitourinary tract. It has been suggested that, since epithelial surfaces are the first line of defense against infection, altered epithelial function in vitamin A deficiency lowers resistance to infection.²

Vitamin D is fat soluble and its sources are butter fat, animal fat, egg yolk, and fish oils. It controls calcium and phosphorous metabolism

and its deficiency may cause the development of bone changes, especially rickets. The role of viosterol, calcium, and bile in the management of the hemorrhagic tendency in jaundice has been stressed by McNealy, Shapiro, and Melnick.²⁷ Osborne, Mendel, and Ferry²⁸ were first to call attention to the occurrence of urinary calculi in rats fed on diets deficient in fat-soluble vitamins, but the exact mechanism of stone formation under these conditions was not clear. More recently the work of Steiner, Zuger, and Kramer²⁹ has done much to clarify the part played by the changes in the lining epithelium of the urinary tract. Higgins³⁰ reports a marked decrease in the number of recurrences of renal calculi when a high vitamin A diet was instituted.

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Methods are now available for the measurement of the state of vitamin C nutrition. In our determinations we have followed the method of Farmer and Abt.⁵ Clinical levels of vitamin C nutrition have been

given by Ingalls and Warren.⁶ Blood plasma levels of 1.0 to 2.0 mg. per cent are considered saturated. Normal is from 0.7 to 1.0 mg. per cent. Low normals run from 0.5 to 0.7 mg. per cent. Suboptimum levels range from 0.3 to 0.5 mg. per cent. Blood plasma levels of vitamin C between 0.15 and 0.3 mg. per cent are considered as asymptomatic scurvy and levels below 0.15 mg. per cent usually are found in cases of clinical scurvy.

Besides the hemorrhagic, bone, and blood changes commonly seen in scurvy, it has been shown that vitamin C also plays a role in resistance to infection. McConkey and Smith⁷ found that, by feeding tuberculous sputum to animals, it could be shown that animals deficient in vitamin C rapidly developed extensive ulceration of the gastrointestinal tract and normal animals did not.

Recent work shows that there are two other less well-known vitamins that are definitely related to the bleeding tendency of patients. Vitamin K is a specific fat-soluble substance, the absence of which in the diet of chicks causes slow blood clotting (Dam⁸). Vitamin K occurs in hogs' liver, some fish, soy beans, and alfalfa (Dam and Schöenheyder⁹). Deficiency of vitamin K in human beings possibly causes some of the obscure hemorrhagic diseases. Neither lemon juice nor cevitamic acid alleviates the symptoms (McCay¹⁰). The other less well-known vitamin has been designated "citrin" or vitamin P. It occurs in lemons and red peppers. Deficiency of this factor causes increased permeability of capillaries.^{11, 12}

DISCUSSION

Alvarez¹³ reports the case of a woman with an ulcer who had bled until her hemoglobin was only 50 per cent. Because of fear, she stayed on a diet of milk, cream, and cereal for months. Her recovery undoubtedly was delayed because of vitamin and iron deficiency. Platt²⁶ reported 4 cases of clinical scurvy in adults. All were on restricted diets. Three of the cases were peptic ulcer patients. Ingalls and Warren⁶ studied the blood plasma level of vitamin C in 20 patients with ulcers and showed that 90 per cent had low levels and 60 per cent had levels that were compatible with those of asymptomatic scurvy. Harris and Abbasy¹⁴ studied the vitamin state of 74 medical and surgical cases. The average daily excretion of the entire group of 74 cases studied was only 8.9 mg. of cevitamic acid as compared with a normal urinary excretion of 13 mg. per day. In this study there were 12 cases of peptic ulcer and 7 other cases classed only as "dyspepsia." These 19 cases all fell below the average of the group with a daily urinary excretion of 5.6 mg. of cevitamic acid. In contrast, Elder and Emery¹⁵ studied a series of ulcer and normal patients and found their diets to balance very closely.

It is evident that borderline states of nutritional instability are common. There is a wide zone between the state of the optimum nutrition and the level at which the classic symptoms of "diet deficiency states" develop.

Wolbach¹⁶ has presented evidence that vitamin C is necessary for the proper growth and multiplication of all supporting tissue cells. It is also necessary for the formation of all intercellular substances which have collagen as their base and is as specifically related to soft tissue repair as is vitamin D to bone growth. Wolbach defines scurvy as an inability to produce and maintain intercellular substance. Proof of this is presented in his and Howe's study¹⁷ of collagen in soft tissue repair. The necessity for optimal vitamin C nutrition in patients is obvious. With others, Smith and McConkey¹⁸ showed that vitamin C deficiency in guinea pigs predisposes to the formation of gastric ulcers. On this finding they suggest the need for a vitamin C source in the diet of ulcer patients.

Following operative cases of peptic ulcer and carcinoma of the stomach, it is not uncommon to encounter cases which show delay in wound healing. Wolbach's work lends evidence in support of the importance of the role of vitamin C in this complication. Payne¹⁹ has analyzed the cause of death in 51 patients who were subjected to operations on the stomach at St. Bartholomew's Hospital during the past sixteen years. Sixteen of these deaths were due to peritonitis; 12 of the 16 apparently originated at the site of the anastomosis where leakage occurred along the suture line. This was apparently due to almost complete lack of fibrin deposit. Lanman and Ingalls²⁰ reported the case of an infant who was operated upon for congenital atresia of the bowel. Postoperatively the child eviscerated and subsequently died. At post mortem the microscopic sections showed evidence of scurvy in the costochondral junctions and sections of the surgical wound showed numerous fibroblasts without the formation of collagen. This case prompted these authors to laparotomize a series of guinea pigs that were on a scorbutogenic diet and a control series maintained on a normal diet. Study of these two groups showed that on application of pressure the laparotomy wounds of the scorbutic group ruptured at a pressure level one-fourth as great as that required to rupture the wounds in the normal group. Study of the wounds of the scorbutic group revealed cyanotic, soft, friable wounds with an absence of collagen formation. These changes were similar to those reported in Wolbach's¹⁶ study of tissue repair in the presence of scurvy.

In Ingalls and Warren's⁶ study of asymptomatic scurvy and its relation to wound healing, they cite a patient with carcinoma of the pylorus who had been on a diet of milk, cream, and eggs for a period of six months. This patient's wound opened postoperatively and a secondary closure was done, but the patient died soon afterward. At the post-

mortem examination, the abdominal wound and the gastrojejunostomy presented a picture compatible with that found in the healing wound of a scorbutic patient.

With regard to peptic ulcer patients on medical management, there is evidence that a vitamin C deficiency may encourage continued bleeding. This hemorrhagic tendency may be due to an impairment of intercellular substance supporting mucosal cells and capillaries. Carlson and Rivers²¹ presented a study of this phase of the problem. Lajos²² work with "citrin," commonly referred to as vitamin P, established its effect on resistance and permeability of capillaries and suggests that a deficiency state may be responsible for the continued bleeding of some peptic ulcers.

We recently undertook a routine study of our surgical cases which gave histories of prolonged dietary management. The findings in our series were so impressive that it prompts us to present this paper, which has as its principal purpose the outline of a scheme of management of patients who are candidates for, or have had, operations upon their gastrointestinal tracts.

In our study we have attempted to outline a dietary regimen that is balanced and affords adequate amounts of minerals, vitamins, and calories. Older diets seem to have shunned foods containing our main source of vitamin C because they were thought to contain too much free acid. In Kugelmass²² study he showed orange juice to have a pH of 3 and tomato juice to have a pH of 4; thus they contain very small amounts of free acid and can be considered fairly good buffers. Recently Dimmler and Power²³ studied the pH of orange juice and found it to vary from 3.63 to 3.99. Gastric juice following Ewald meals showed pH values varying from 1.12 to 7.07 with a mode of 1.6. Mixtures of one part of orange juice and four parts of gastric juice were studied both in vivo and in vitro. These mixtures showed pH values of 1.3 to 4.6. Thus, the orange juice lowered high gastric acidities and raised low gastric acidities. From this work it is reasonable to conclude that orange juice may be given safely to patients with peptic ulcer.

Preoperatively we have attempted to determine diets which fulfill the needs of the individual patients. It has been our plan to include those nonirritating, easily digested foods which are good sources of minerals, vitamins, complete proteins, and calories. Vitamin concentrates, such as cevitamic acid, brewers' yeast, and A.B.D. concentrates, are used because the quantity of food may have to be restricted. By their use, normal levels may be more quickly restored in the body. In the absence of free hydrochloric acid, as shown by gastric analysis, hydrochloric acid should be supplied, since it helps to decrease the amount of infection present in the stomach. Gastric cases showing obstruction should be adequately decompressed before surgery is attempted, to restore the stomach to as near normal as possible (McNealy and

Lichtenstein²⁴). We have felt that material aspirated from the stomach during the period of decompression and restoration of positive pyloric balance might contain essential hormones, enzymes, or vital factors. To prevent their loss, we routinely administer the aspirated material to the patient by proctoclysis. It is usually added to the rectal drip of normal salt solution.

Postoperatively, we have kept patients in a state of fluid and chemical balance by adhering to the principles of water exchange as advocated by Coller, Dick, and Maddock.²⁵ During the first four days, postoperative patients are usually too ill to tolerate attempts to balance their diets. They ordinarily receive only 400 to 700 calories per day during this period and this is supplied almost entirely by glucose. By the fifth day, vitamin concentrates usually can be given by mouth. If, during the first four-day period, it seems imperative to augment vitamin C, this can be done parenterally. A study of the regimen we suggest shows that by the eighth postoperative day the caloric intake has reached 1,300 calories and by the end of two weeks the total caloric intake is nearly 2,000 calories and contains 56 gm. of protein, 1.1 gm. calcium, 1.3 gm. of phosphorus, and 13.7 mg. of iron. Even though this diet more than fulfills the requirements of most bed patients, it is steadily increased until on the fortieth day eight feedings with a maximum amount of five ounces are given. At this time the diet yields 2,825 calories and contains 86 gm. of protein, 2.5 gm. of calcium, 2.0 gm. phosphorus, 14.2 mg. of iron besides liberal amounts of each of the vitamins. If, however, chemical tests and physical findings indicate that the patient's depleted reserves have been fully restored, the diet is curtailed.

No restricted schedule of dietary management can be devised which will satisfy the requirements and the appetites of all the patients without modifications. For this reason, a considerable number of substitute foods have been included which may be used without materially changing the nutritional value of the diet. As milk, eggs, and cereals form the basis of this regimen, it is essential that the preparation and methods of serving be varied to prevent monotony.

SUGGESTED REGIMEN

General Directions.—

1. The patient is weighed on admission to the hospital and on the day before operation if his condition permits. He is weighed as soon after operation as his condition warrants and twice a week thereafter.

2. The postoperative administration of vitamin concentrates is begun on the fifth day. Cevitamic acid is given daily until the blood concentration reaches 1 mg. per 100 c.c. blood. Melvaron* is administered during the entire period of hospitalization.

*Supplied through courtesy of Eli Lilly Company. One fluid ounce contains: 28,000 U.S.P. units vitamin A, 8,000 U.S.P. units vitamin D, 1/12 International unit vitamin B, and 35 Sherman units B₆.

mortem examination, the abdominal wound and the gastrojejunostomy presented a picture compatible with that found in the healing wound of a scorbutic patient.

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3. Jaundiced patients receive viosterol, 30 drops, t.i.d.; calcium, glucose, and bile salts if stools are acholic.

Laboratory Determinations:

Urinalysis.

Complete blood count.

Quantitative determination of blood cevitic acid.

Jaundiced patients, Ivy bleeding time.

Weigh patient; record height.

Fluids:

Hydration and chemical equilibrium by salt solution, Hartman's or Ringer's solution.

Caloric complement by 5 per cent glucose solution intravenously or subcutaneously. The glucose to be given in distilled water unless the patient is chloride deficient.

Operative Day.—

Diet:

No food.

Fluids by mouth not given for the six hours preceding operation.

Medication:

Preoperative: Use of narcotics as ordered.

Postoperative: Morphine or its derivatives.

Fluids:

1,000 c.c. 5 per cent glucose solution administered subcutaneously in the loose axillary tissues during the operation.

1,000 c.c. 5 per cent glucose solution administered intravenously during the afternoon.

1,000 c.c. normal saline subcutaneously or intravenously during the night.

No enemas.

First Postoperative Day.—

Diet:

Nothing by mouth.

Medication:

Narcotics for pain or restlessness as ordered.

Fluids:

1,000 c.c. 5 per cent glucose solution subcutaneously during the morning.

1,000 c.c. normal salt solution intravenously during the afternoon.

1,000 c.c. 5 per cent glucose solution intravenously during the night.

Rectal tube for gas.

Second Postoperative Day.—

Diet:

Nothing by mouth except warm water and tea. Begin with teaspoonful administrations and, if tolerated, give at the rate of one ounce every hour.

Fluids:

5 per cent glucose solution and normal salt solution to supply at least 3,000 c.c. of fluid during the twenty-four-hour period.

Third Postoperative Day.—

Diet:

One ounce liquid every hour from 7:00 A.M. to 9:00 P.M. Water, tea, sweetened, cooked fruit juice (except grape), and milk mixture* (half milk, half cream) are allowed. Serve sugar with the tea.

*See page 54. Paragraph 5, General Directions.

3. Iron therapy is begun on the tenth day and continued until the hemoglobin reaches 90 per cent.

4. The twenty-four-hour fluid intake is maintained at a minimum of 3,000 c.c. during the entire period of hospitalization.

5. Two egg whites are added to the fruit juice or milk mixture daily between the third and fifteenth postoperative days.

6. Cereal, in the form of pabulum,* is added to the diet on the sixth day and continued until the twenty-third day, when farina, cornmeal, rice, and strained oatmeal may be substituted. Pabulum is used because it is high in minerals and vitamins. It is prepared for serving by heating 5 gm. in 1 ounce milk mixture for each ounce of cereal ordered.

7. Puréed asparagus, carrots, peas, spinach, and squash are allowed on the thirteenth day. By the seventeenth day baked, baked-stuffed, boiled, creamed escalloped, and mashed potatoes may be substituted for the puréed vegetables.

8. Until the ninth day the eggs should be poached, soft boiled, or coddled. Thereafter, they may be served creamed or as soufflé or omelet.

9. Beginning on the ninth day, the following may be substituted for the milk mixture: eggnog, malted milk, cocoa, coco-malt, cal-c-malt, and banana milk. As soon as the patient regains his normal weight, the cream should be omitted in the preparation of these beverages.

10. The desserts allowed after the fourteenth day are ice cream, sherbets; banana, prune, or apricot whips; rice tapioca; bread, floating island, blanc mange, chocolate, butterscotch puddings; angelfood or sponge cake; plain or whipped gelatin.

11. Beginning on the fourteenth day, two ounces of cottage cheese may be substituted for one egg.

12. After the twenty-third day, baked noodles may be used in place of potatoes.

13. Beginning on the twenty-fifth day, canned peaches, pears, or peeled apricots may be given. Six days later peeled prunes, applesauce, baked apple (skin removed), ripe bananas, and grapefruit are added.

14. Tender boiled, broiled, or baked fish may be added on the thirty-first day.

REGIMEN

Preoperative Care.—

Diet:

As prescribed by attending surgeon. It should usually consist of a readily assimilable, nonresidue diet containing no seeds or coarse cellulose fibers.

Medication:

1. If patient can tolerate vitamin concentrates, administer $\frac{1}{2}$ ounce melvaron, t.i.d.
2. Tablets of cevitamic acid; two 25 mg. tablets, t.i.d.

*Mead Johnson—analysis: protein, 15 per cent; fat, 3 per cent; carbohydrate, 70.8 per cent; moisture, 7 per cent; calcium, 0.78 per cent; phosphorus, 0.62 per cent; iron, 0.23 per cent; copper, 0.0013 per cent.

Fourteenth Postoperative Day.—

Dessert allowed.*

Seventeenth Postoperative Day.—

Diet:

Feedings every two hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 6 ounces per feeding.

Laboratory Tests:

Urinalysis.

Complete blood count and hemoglobin determination.

Quantitative cevitamic acid determination of blood.

Twenty-First Postoperative Day.—

Diet:

Feedings every two hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 8 ounces per feeding.

Twenty-third Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 9 ounces per feeding.†

Twenty-fourth Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 9 ounces per feeding.

Laboratory Tests:

Urinalysis.

Complete blood count and hemoglobin determination.

Quantitative cevitamic acid determination of blood.

Twenty-Fifth Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 10 ounces per feeding.‡

Twenty-Ninth Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 12 ounces per feeding.

Thirty-First Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 14 ounces per feeding.§

Laboratory Tests:

Urinalysis.

Complete blood count and hemoglobin determination.

Quantitative cevitamic acid determination of blood.

Thirty-Sixth Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 16 ounces per feeding.

*See page 54. Paragraphs 10 and 11, General Directions.

†See page 54. Paragraph 12, General Directions.

‡See page 54. Paragraph 13, General Directions.

§See page 54. Paragraph 14, General Directions.

Laboratory Tests:

Urinalysis.

Complete blood count and hemoglobin determination.

Quantitative cevitic acid determination of blood.

Fluids:

5 per cent glucose solution and normal salt solution to supply 3,000 c.c. fluid during the twenty-four-hour period. The oral intake should be used in computing the minimum 3,000 c.c. requirement.

*Fourth Postoperative Day.—**Diet:*

Two ounces liquid every hour from 7:00 A.M. to 9:00 P.M.

Fluids:

Total minimum to be 3,000 c.c. in twenty-four hours.

*Fifth Postoperative Day.—**Diet:*

Two ounces liquid every hours from 7:00 A.M. to 9:00 P.M. Total fluids to be kept at 3,000 c.c.

Medication:

Begin the administration of vitamin concentrates.

 $\frac{1}{2}$ ounce melvaron, t.i.d.

Two 25 mg. cevitic acid tablets, t.i.d.

Sixth Postoperative Day.—

Cereal added.*

Seventh Postoperative Day.—

Same as above.

*Eighth Postoperative Day.—**Diet:*

Water may be given in 2-ounce quantities as the patient desires in addition to diet. Total fluids must be kept up to 3,000 c.c.

*Ninth Postoperative Day.—**Diet:*

Feedings every two hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 4 ounces per feeding.†

Fluids:

If oral water and liquid diet does not total 3,000 c.c. in twenty-four-hour period, salt solution by rectal or intravenous drip should be used.

*Tenth Postoperative Day.—**Diet:*

Feedings every two hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 4 ounces per feeding.

Medication:

Begin administration of iron.

Laboratory Tests:

Urinalysis.

Complete blood count and hemoglobin determination.

Quantitative cevitic acid determination of blood.

*Thirtieth Postoperative Day.—**Diet:*

Feedings every two hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 5 ounces per feeding. Puréed vegetable allowed.‡

*See page 54. Paragraph 6, General Directions.

†See page 54. Paragraphs 8 and 9, General Directions.

‡See page 54. Paragraph 7, General Directions.

TABLE I.—CONT'D

POSTOPERATIVE DAY	9TH AND 10TH DAYS	11TH AND 12TH DAYS	13TH AND 14TH DAYS
MAXIMUM QUANTITY	4 OZ. EVERY 2 HR.	4 OZ. EVERY 2 HR.	5 OZ. EVERY 2 HR.
7 A.M.	2 oz. cereal 1 oz. milk mixture 1 egg	2 oz. cereal 1 oz. cream 1 egg	1 egg 1 oz. cream 1 strip bacon 2 oz. cereal
9 A.M.	4 oz. orange juice	4 oz. orange juice	5 oz. orange juice
11 A.M.	4 oz. milk mixture	4 oz. milk mixture	2 oz. cream 3 oz. cereal
1 P.M.	1 soft cooked egg 2 oz. cereal 1 oz. milk mixture	1 soft cooked egg 2 oz. cereal 1 oz. cream	1 soft cooked egg 2 oz. puréed vegetable 2 oz. milk mixture 10 gm. butter—in vegetable
3 P.M.	4 oz. milk mixture	4 oz. ice cream, custard, or jello	4 oz. ice cream, custard, or jello
5 P.M.	1 soft cooked egg 3 oz. milk mixture	1 soft cooked egg 3 oz. milk mixture	1 soft cooked egg 4 oz. milk mixture
7 P.M.	4 oz. fruit juice	4 oz. fruit juice	5 oz. fruit juice
9 P.M.	4 oz. milk mixture	4 oz. milk mixture	5 oz. milk mixture

In January he developed a recurrence of symptoms and bleeding from the ulcer occurred. His symptoms and bleeding were refractory to a modified Sippy regimen and to mucin treatment. His weight was 104 pounds; hemoglobin, 60 per cent; R.B.C., 2.99; and blood cevitic acid was 0.44 mg. per cent.

At operation a Polya type partial resection was performed. Convalescence was good except for a mild respiratory infection. The patient experienced no difficulty in taking the regular postoperative feedings provided the eggs were incorporated in the beverages. On discharge from the hospital weight was 105 pounds; hemoglobin, 64 per cent; R.B.C., 3.6; and blood cevitic acid was 0.84 mg. per cent. Surgical wound was clean and well healed.

CASE 2.—Patient F. K., female, aged 47 years. This patient gave a history of fulness, belching, and distention for eight weeks, but she had been unable to retain food for four weeks prior to admission because of severe nausea and vomiting. There had been a weight loss of twenty pounds. Her weight was 105 pounds; hemoglobin, 93 per cent; R.B.C., 4.6; blood cevitic acid was 0.16 mg. per cent.

Workup showed a pyloric obstruction due to carcinoma of the stomach. She was placed on our regimen and prepared for surgery. At operation a large infiltrating carcinoma was found. A Polya type subtotal gastric resection was performed.

Postoperatively the regimen was well tolerated. Patient vomited only once, that being on the fifth postoperative day. Convalescence was very smooth. Weight increased to 111½ pounds; hemoglobin was 80 per cent; R.B.C., 4.5; blood cevitic acid was 1.56 mg. per cent. Operative wound was clean and completely healed.

CASE 3.—Patient F. H., female, aged 46 years. This patient was acutely ill when first seen. She gave a history of chronic gall-bladder disease over a period of sixteen years; present attack was of ten days' duration; severe right upper quadrant pain had been accompanied by such persistent vomiting that she had been unable to retain food. Temperature ranged from 100 to 102° F. A large extremely tender mass was present in the right upper quadrant and it extended almost to the crest of the ilium. Icterus index was 40 and blood plasma cevitic acid was 0.38 mg. per cent. Hemoglobin was 90 per cent and R.B.C., 5; W.B.C. was 18,700.

TABLE I
HOURLY DIET REGIMEN

POSTOPERATIVE DAY	3RD DAY	4TH AND 5TH DAYS	6TH AND 7TH DAYS	8TH DAY
MAXIMUM QUANTITY	1 OZ. EVERY HOUR	2 OZ. EVERY HOUR	2 OZ. EVERY HOUR	2 OZ. EVERY HOUR
7 A.M.	1 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice
8 A.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture
9 A.M.	1 oz. milk mix- ture	2 oz. milk mix- ture	1 oz. milk mix- ture 1 oz. cereal	1 oz. milk mix- ture 1 oz. cereal
10 A.M.	1 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice
11 A.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture
12 M.	1 oz. milk mix- ture	1 oz. milk mix- ture 1 egg	1 oz. milk mix- ture 1 egg	1 oz. milk mix- ture 1 egg
1 P.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture
2 P.M.	1 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice
3 P.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture
4 P.M.	1 oz. milk mix- ture	2 oz. milk mix- ture	1 oz. milk mix- ture 1 egg	1 oz. milk mix- ture 1 egg
5 P.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture
6 P.M.	1 oz. fruit juice	2 oz. fruit juice	2 oz. fruit juice	2 oz. milk mix- ture
7 P.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture
8 P.M.	1 oz. milk mix- ture	2 oz. milk mix- ture	2 oz. milk mix- ture	2 oz. fruit juice
9 P.M.	1 oz. water or tea	2 oz. water or tea	2 oz. water or tea	2 oz. milk mix- ture

Thirty-Eighth Postoperative Day.—

Diet:

Feedings every three hours from 7:00 A.M. to 9:00 P.M. Maximum quantity, 16 ounces per feeding.

Laboratory Tests:

Complete blood count and hemoglobin determination.

Quantitative cevitamic acid determination of blood.

CASE EXAMPLES

CASE 1.—Patient F. T., male, aged 55 years. This patient gave an ulcer history of eight years' duration. He had been placed on Sippy management but only stayed on management as long as symptoms were present. He was employed as a cook and found it difficult to eat meals regularly. He developed the habit of gulping his food while working. His usual daily intake consisted of ice-cold milk, French fried potatoes, meat, and a little fruit.

TABLE I.—CONT'D

POSTOPERATIVE DAY	9TH AND 10TH DAYS	11TH AND 12TH DAYS	13TH AND 14TH DAYS
MAXIMUM QUANTITY	4 OZ. EVERY 2 HR.	4 OZ. EVERY 2 HR.	5 OZ. EVERY 2 HR.
7 A.M.	2 oz. cereal 1 oz. milk mixture 1 egg	2 oz. cereal 1 oz. cream 1 egg	1 egg 1 oz. cream 1 strip bacon 2 oz. cereal
9 A.M.	4 oz. orange juice	4 oz. orange juice	5 oz. orange juice
11 A.M.	4 oz. milk mixture	4 oz. milk mixture	2 oz. cream 3 oz. cereal
1 P.M.	1 soft cooked egg 2 oz. cereal 1 oz. milk mixture	1 soft cooked egg 2 oz. cereal 1 oz. cream	1 soft cooked egg 2 oz. puréed vegetable 2 oz. milk mixture 10 gm. butter—in vegetable
3 P.M.	4 oz. milk mixture	4 oz. ice cream, custard, or jello	4 oz. ice cream, custard, or jello
5 P.M.	1 soft cooked egg 3 oz. milk mixture	1 soft cooked egg 3 oz. milk mixture	1 soft cooked egg 4 oz. milk mixture
7 P.M.	4 oz. fruit juice	4 oz. fruit juice	5 oz. fruit juice
9 P.M.	4 oz. milk mixture	4 oz. milk mixture	5 oz. milk mixture

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TABLE I.—CONT'D

POSTOPERATIVE				
DAY	15TH AND 16TH DAYS	17TH AND 18TH DAYS	19TH AND 20TH DAYS	21ST AND 22ND DAYS
MAXIMUM FEEDING	5 oz.	6 oz.	6 oz.	7 oz.
NO. OF FEEDINGS	8	8	8	8
7 A.M.	1 slice toast	1 slice toast	1 slice toast	1 slice toast
	1 square butter	1 square butter	1 square butter	1 square butter
	1 oz. cream	1 oz. cream	1 oz. cream	2 oz. cream
	1 oz. cereal	2 oz. cereal	2 oz. cereal	2 oz. cereal
	1 egg	1 egg	1 egg	1 egg
9 A.M.	5 oz. orange juice	6 oz. orange juice	6 oz. orange juice	6 oz. orange juice
11 A.M.	2 oz. cream	6 oz. cream	6 oz. cream	6 oz. cream
		soup	soup	soup
	3 oz. cereal	3 crackers	3 crackers	3 crackers
1 P.M.	1 strip bacon	1 strip bacon	1 slice toast	1 slice toast
	1 egg	1 egg	2 oz. dessert	3 oz. dessert
	2 oz. puréed vegetable	2 oz. puréed vegetable or potato	2 oz. puréed vegetable or potato	2 oz. puréed vegetable or potato
	1 square butter	1 square butter	2 squares but- ter	2 squares but- ter
		1 oz. cream	1 oz. cream	1 oz. cream
3 P.M.	4 oz. dessert	4 oz. dessert	4 oz. dessert	4 oz. dessert
5 P.M.	1 egg	1 egg	1 egg	1 egg
	2 oz. milk mix- ture	3 oz. milk mix- ture	3 oz. milk mix- ture	4 oz. milk mix- ture
	1 slice toast	1 slice toast	1 slice toast	1 slice toast
	1 square butter	1 square butter	1 square butter	1 square butter
7 P.M.	5 oz. beverage	6 oz. beverage	6 oz. beverage	7 oz. beverage
9 P.M.	5 oz. beverage	6 oz. beverage	6 oz. beverage	7 oz. beverage

On conservative treatment the gall bladder mass disappeared and the patient's condition improved markedly, except that R.B.C. fell to 3.6 and Hb. 54 per cent. At time of operation R.B.C. was 4 and Hb. 64 per cent. Blood cevitic acid was 0.88 mg. per cent. A much thickened gall bladder containing stones was removed and a cholecystocolic fistula was closed. Convalescence was excellent and laparotomy wound healed without signs of infection. Regimen was well tolerated.

CASE 4.—Patient W. M., male, aged 40 years. This was a case of chronic peptic ulcer of four years' duration. Patient had been treated for peptic ulcers in 1934 but had followed his diet only a short time before he resumed his former eating habits.

For ten days prior to admittance to the hospital he had symptoms of severe pain and repeated vomiting. Weight was 101 pounds; R.B.C., 4.7; hemoglobin, 87 per cent; and W.B.C., 11,800. Gastric analysis showed free acid of 64 and a total of 94. Blood cevitic acid was 0.32 mg. per cent.

This case appeared to be one of a penetrating ulcer with some pyloric obstruction. At operation a walled-off perforated ulcer was found and a Polya type resection was performed. Postoperatively patient ran a stormy course; he had considerable fever, developed a diarrhea, and had an infected wound. Because of these complications, it was difficult to meet optimum nutritional requirements. On discharge, patient weighed 83 pounds; hemoglobin was 64 per cent; R.B.C., 4; blood cevitic acid, 0.4 mg. per cent. We have felt that, though the result in this patient was far from ideal, it might have been worse if no attempt had been made to supply deficient food factors.

TABLE I.—CONT'D

POSTOPERATIVE DAY	23RD AND 24TH DAYS	25TH, 26TH, 27TH, AND 28TH DAYS	29TH AND 30TH DAYS
MAXIMUM FEEDING	9 oz.	10 oz.	12 oz.
NO. OF FEEDINGS	6	6	6
7 A.M.	1 slice toast 1 square butter 2 oz. cream 1 oz. milk mixture 3 oz. cereal 1 egg	1 slice toast 1 square butter 2 ounces cream 1 oz. milk mixture 4 oz. cereal 1 egg	1 slice toast 1 square butter 2 oz. cream 1 oz. milk mixture 4 oz. cereal 1 egg or 3 strips bacon
10 A.M.	6 oz. orange juice	6 oz. orange juice	6 oz. orange juice 1 slice bread 1 square butter
12 M.	6 oz. cream soup 3 crackers 2 oz. baked noodle or potatoes 1 square butter 2 strips bacon	6 oz. cream soup 3 crackers 2 oz. baked noodles or potatoes 1 square butter 2 oz. canned peaches, pears, or peeled apricots	6 oz. cream soup 3 crackers 2 oz. boiled or broiled chicken or fish 2 squares butter 2 oz. canned pears, peaches, or peeled apricots
3 P.M.	4 oz. dessert 5 oz. beverage	4 oz. dessert 6 oz. beverage	4 oz. dessert 6 oz. beverage
6 P.M.	1 egg 2 oz. puréed vegetable 1 square butter 4 oz. milk mixture or fruit juice	1 egg 2 oz. puréed vege- table 1 square butter 3 oz. dessert 2 oz. milk mixture	2 oz. puréed vege- table or potato 1 square butter 3 oz. dessert 4 oz. milk mixture
9 P.M.	9 oz. beverage	9 oz. beverage	9 oz. beverage

CASE 5.—L. F., female, aged 31 years. This patient gave a history of having a pelvic infection in 1929; in 1937 she was operated upon twice because she presented symptoms of a partial intestinal obstruction. When seen, she presented evidence of a severe nutritional disturbance as a result of the old pelvic infection and bowel interference from adhesions. Weight was 75 pounds; Hb., 44 per cent; and R.B.C., 2.6. Blood cevitic acid was 0.44 mg. per cent.

This patient was put on a high caloric antianemic diet supplemented by vitamin concentrates and in a period of twenty-six days weight had increased to 85 pounds; Hb. was 55 per cent and R.B.C., 2.8. Cevitic acid level was 1.08. Patient was much improved and was not operated upon.

CASE 6.—H. S., female, aged 70 years. This was a case of carcinoma of the stomach in an elderly female. Weight was 119 pounds; Hb., 40 per cent; R.B.C., 2.8; and blood cevitic acid, 1.04 mg. per cent. Stomach was decompressed and patient given three transfusions prior to operation. At this time Hb. was 76 per cent and R.B.C., 5. A Polya resection was performed; postoperative course was fair except for a low-grade wound infection. Regimen was well tolerated. At time of discharge on thirty-sixth postoperative day, weight was 114 pounds; Hb., 65 per cent; R.B.C., 4.3; and blood cevitic acid, 0.96 mg. per cent.

CASE 7.—Patient R. F., female, aged 36 years. This patient was acutely ill when first seen. She was markedly dehydrated; gums were spongy and bled freely; body was covered with perifollicular ecchymoses. The extremities were covered with perifollicular hemorrhages and the legs also showed periosteal hemor-

TABLE I.—CONT'D

POSTOPERATIVE DAY	31ST-35TH DAYS	36TH-40TH DAYS
MAXIMUM FEEDING	14 oz.	16 oz.
NO. OF FEEDINGS	6	6
7 A.M.	1 oz. fruit 2 slices toast 2 squares butter 2 oz. cream 4 oz. cereal 1 egg or 3 strips bacon 2 oz. milk	3 oz. fruit 2 slices toast 2 squares butter 2 oz. cream 4 oz. cereal 1 egg or 3 strips bacon 2 oz. milk
10 A.M.	6 oz. orange juice 1 slice bread 1 square butter	6 oz. orange juice 1 slice bread 1 square butter
12 M.	6 oz. cream soup 3 crackers 1 egg or substitute 2 oz. puréed vegetable 2 squares butter 1 slice bread 2 oz. fruit	6 oz. cream soup 3 crackers 1 egg or substitute 2 oz. puréed vegetable 2 squares butter 2 slices bread 3 oz. fruit
3 P.M.	4 oz. dessert 8 oz. beverage	4 oz. dessert 8 oz. beverage
6 P.M.	2 oz. puréed vegetable 1 slice bread 2 squares butter 1 egg or substitute 3 oz. fruit or dessert 6 oz. beverage	2 oz. puréed vegetable 2 slices bread 2 squares butter 1 egg or substitute 3 oz. fruit or dessert 6 oz. beverage
9 P.M.	8 oz. beverage	8 oz. beverage

rhages. The abdomen was markedly distended and a distinct bowel pattern was visible through the abdominal wall. Rectally, a hard, constricting, infiltrating mass was felt.

A history of bowel disturbance and loss of 30 pounds in weight over a period of six months was elicited. The patient was a religious woman who had not sought the advice of a physician but had "dieted" herself. Her diet consisted of milk and tea.

Blood cevitamic acid levels on two determinations showed values of 0.06 mg. per cent and 0.12 mg. per cent. Attempt at conservative decompression was unsuccessful and a cecostomy was performed after water and chemical balance was restored to as near normal as was possible. This patient expired three days later.

This case of carcinoma of the rectum, intestinal obstruction, and scurvy illustrates dramatically the high degree of deficiency disease that is possible in neglected patients.

CONCLUSIONS

From the evidence presented, it is apparent that borderline nutritional disturbances are common in many gastrointestinal conditions, especially in cases of peptic ulcer and carcinoma of the stomach. Deficiency of vitamins A, B, and C may initiate or perpetuate ulcerative lesions of the gastrointestinal tract. The health of the alimentary canal is especially dependent on adequate amounts of the vitamins B and C. Vita-

TABLE II
FOOD VALUES, POSTOPERATIVE DIET

	C	P	F	CALORIES	CA	P	FE
Operative day	100			400			
First postoperative day	100			400			
Second postoperative day	100			400			
Third postoperative day	141	3.9	14.4	718	.128	.10	.24
Fourth postoperative day	81	22.0	30.6	702	.267	.27	1.74
Fifth postoperative day	81	22.0	30.6	702	.267	.27	1.74
Sixth postoperative day	83	28.5	32.3	752	.307	.271	4.44
Seventh postoperative day	83	28.5	32.3	752	.307	.271	4.44
Eighth postoperative day	117	38.7	71.5	1,336	.691	.671	5.16
Ninth postoperative day	89	51.5	87.8	1,407	.969	1.121	11.38
Tenth postoperative day	89	51.5	87.8	1,407	.969	1.121	11.38
Eleventh postoperative day	103	51.7	92.7	1,563	.931	1.113	11.39
Twelfth postoperative day	103	51.7	92.7	1,563	.931	1.113	11.39
Thirteenth postoperative day	124	56.9	131.5	1,952	1.136	1.329	13.73
Fourteenth postoperative day	124	56.9	131.5	1,952	1.136	1.329	13.73
15th and 16th postoperative days	100.0	49.6	141.0	1,880	1.035	1.278	12.09
17th and 18th postoperative days	108.9	54.0	144.7	1,963	1.870	1.401	9.89
19th and 20th postoperative days	126.4	49.6	145.7	2,031	1.879	1.357	8.71
21st and 22nd postoperative days	132.4	53.8	165.3	2,242	2.023	1.473	9.04
23rd and 24th postoperative days	122.1	48.9	144.9	1,986	1.876	1.352	10.26
25th, 26th, 27th, 28th postoperative days	156.6	56.1	142.9	2,173	2.036	1.494	11.01
29th and 30th postoperative days	189.0	69.3	175.2	2,613	2.177	1.674	11.07
31st-35th postoperative days	217.0	82.6	160.2	2,650	2.561	2.012	14.28
36th-40th postoperative days	256.4	86.3	160.4	2,825	2.571	2.048	14.28

min C has a definite effect on fibroplastic healing and general reparative processes and adequate amounts are necessary to insure normal postoperative healing. Vitamin D in the form of viosterol has been shown to influence favorably the hemorrhagic tendency in jaundice when given in with bile. It is also suggested that deficiency of vitamin C and the two lesser known vitamins, K and P, may be important in cases that show continued bleeding. The administration of orange juice has no deleterious effect on cases of high acidity, but rather lowers the acidity. Vitamin C also may be supplied in the form of cevitamic acid tablets and in cases that have marked pyloric obstruction it may be administered parenterally.

In the diets we are presenting, we have attempted to balance the mineral and vitamin content and postoperatively we are supplying the patient with a more adequate caloric intake. In our cases the regimen has been well tolerated and we feel that the well-being of patients has been improved under this management.

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ACUTE PERFORATED DUODENAL DIVERTICULUM

A CASE REPORT

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DIVERTICULA of the duodenum have been reported since 1710¹ but their frequency has only been recognized since the recent development of better x-ray technique. The incidence of duodenal diverticula has been reported to be as high as 1.2 per cent.

Diverticula of the duodenum occur more frequently in the latter decades of life. Diagnosis is difficult. The symptoms are usually suggestive of chronic appendicitis, peptic ulcer, gall-bladder disease, or colitis. There is nothing typical of the symptoms. Even when x-ray findings are positive, the gastrointestinal complaints are not necessarily caused by the diverticulum.

Diverticula may be found on all parts of the duodenal wall, but the usual site is on the descending part and in the region of the ampulla of Vater. Usually the diverticulum springs from the inner and posterior aspect of the duodenum along the line of entrance of the vessels. The mucosa and muscularis mucosa are protruded through the muscular wall. Thus, the diverticulum is very thin and it would seem that perforation would be common. However, as a matter of fact, I was able to find only a very few instances of acute perforation of a duodenal diverticulum reported in the literature. Hahn² reported two cases with recovery. Monsarrot³ had one patient who also recovered. Thorek⁴ had a case associated with duodenal ulcer and Lucinian⁴ reported a remarkable case of a perforated duodenal diverticulum which was diagnosed by x-ray.

Due to the rarity of this disease and the difficulty of making an operative or preoperative diagnosis, I think the following case worthy of report.

CASE REPORT.—A white male, aged 59 years, entered the hospital with the following history: He had awakened at his regular time and gone about the usual activities of farming. After a hearty luncheon, he was resting on the porch when, at about 2 P.M., he was suddenly seized with an intense upper abdominal pain which was so severe that he broke out in a profuse perspiration. He was assisted to a bed and his wife tried to relieve him by the administration of local applications, emetics, and enemas. Finally he was persuaded to send for a physician who saw him at 6 P.M. The family physician made a diagnosis of a perforated ulcer and advised that he come to the city for an immediate operation. After some deliberation and delay, the patient was persuaded to come to the hospital, which he entered at 1 A.M. He stated that he had never been sick before. He denied ever having had indigestion, gas, or any other digestive disturbance. His family history and marital history were irrelevant.

On examination he was found to be a well-nourished white male weighing 175 pounds and having a height of six feet. His temperature was 98.6; pulse, 90;

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The patient left the operating room with a blood pressure of 120/80 and a full and regular pulse of 96. Two hours later symptoms of shock appeared, his blood pressure dropping to 80/50 and the pulse developing a rate of 140. Supportive treatment was begun but the patient died within another hour.

At autopsy nothing of importance was found, except around the duodenum. There were small collections of a creamy exudate along the anterior surface of the duodenum. No ulcers were palpated. The peritoneum was stripped off and a large collection of pus and duodenal contents (about 100 c.c.) was found along the second portion of the duodenum. The fluid lay between the duodenum and the head of the pancreas and in front of the right kidney. The duodenum was pulled out of its bed and a diverticulum about the size and shape of the index finger ($2\frac{1}{2}$ inches long and $\frac{1}{2}$ inch in diameter) was found in this collection of creamy fluid. The duodenum was split and the opening of the diverticulum was discovered $\frac{1}{4}$ inch below the entrance of the common duct. This is the usual site for the openings of duodenal diverticula. There was a match-stick perforation at the tip of the diverticulum which was very thin and did not contain a muscular layer.

SUMMARY

A case of a perforated duodenal diverticulum is presented. The symptoms and signs are similar to those of a perforated peptic ulcer. The diagnosis may be missed, as it was in this patient, unless the possibility of such a condition is kept in mind. I would suggest that if the signs and symptoms point to a perforated ulcer and the intraperitoneal pathology reveals nothing more than an exudate along the anterior duodenal wall a small incision be made in the posterior peritoneum and a search begun for a diverticulum.

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respiration, 22; and blood pressure, 120/78. The remainder of the physical examination was normal, with the exception of the findings in the abdomen.

The upper half of the abdomen did not move with respiration. There was very little tympanites and no distention. The upper half was boardlike, but the lower half was quite soft. Except in the epigastrium there was very little tenderness. On auscultation the abdomen was quiet.

The urine was normal. The hemoglobin was 95 per cent; there were 5,000,000 reds and 8,500 white cells with 86 per cent polymorphonuclears and 14 per cent lymphocytes. The shift was to the left.

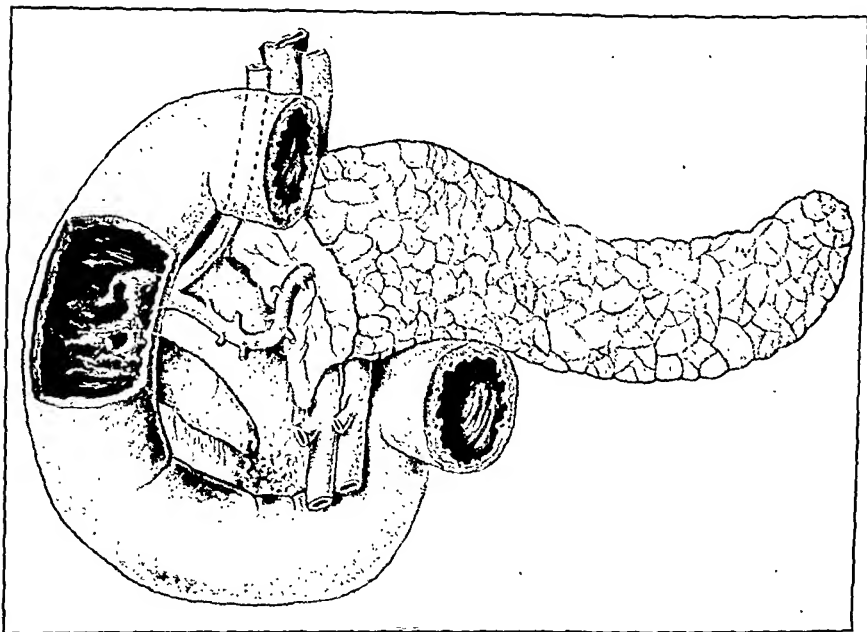


Fig. 1.—A diagrammatic sketch showing a perforated duodenal diverticulum. The head of the pancreas was omitted from drawing and a small window was made in the anterior wall of the duodenum to demonstrate the diverticulum and its perforation at the tip.

The diagnosis of perforated peptic ulcer was concurred in and the patient was prepared for an immediate laparotomy. Under ether anesthesia, which was preceded by an infusion, the patient received an upper right rectus incision. The rigidity persisted to some extent with the patient fully under the anesthetic. The peritoneum was opened, but no escape of gas was noted. About 300 c.c. of a creamy exudate was aspirated from Morrison's pouch and a search started for the perforation. The entire duodenum was apparently free of ulceration. Some of this exudate adhered to the second portion of the duodenum. The stomach was normal. The appendix was found to be acutely inflamed and was removed. There was no perforation in this organ. The remainder of the intestines were injected, but no perforations were found. The pancreas and spleen were normal. The gall bladder was tense and did not empty. There were rather dense adhesions between the stomach and gall bladder. The adhesions were freed and a cholecystostomy performed in the hope that possibly the gall bladder would account for the large amount of exudate. There was no pus in the bile obtained from the aspiration of the gall bladder. The abdomen was closed with the fear that the correct diagnosis had not been discovered.

cases involving the omentum herein reported. Torsion could be demonstrated in only 1 of the 3 cases involving epiploic appendages. In the other 2 cases the etiology was not known. The epiploon had the appearance of being involved in an inflammatory process, but it could not be demonstrated to have come from the adjacent colon.

The etiology of the torsion is unknown. In one of our cases the pain started suddenly, as the patient turned over in bed. Numerous etiologic possibilities have been suggested in the literature:

1. There is sudden rotation of the body or violent exertion.^{5, 6} Only one of our patients gave such a history.

2. There is often a congenital malformation of the omentum^{8, 9} so that the part involved is long and narrow and therefore easily twisted on itself.

3. The anatomic arrangement of the vessels may be such that the long tortuous veins twist around the short arteries as the omentum swings from the transverse colon.⁶

4. Venous thrombosis may be the first lesion.¹¹ The veins would then become distended and would easily rotate around the arteries. Thrombosis of the vessels is always found at operation, but it cannot be demonstrated that it was present before the torsion.

5. An inflammatory process starts first⁷ and the torsion follows as the heavy inflamed omentum swings from the unaffected area.

6. The omentum, heavy with fat, is a good subject for torsion, as it swings from the transverse colon. Farr and Bachman¹¹ have suggested that torsion is more apt to occur in well-nourished individuals. This has been our experience.

PATHOLOGY

The cases involving the omentum herein reported are all samples of primary torsions resulting in acute epiploitis. It seems likely, therefore, that the torsion is the original incident and that thrombosis and strangulation follow this. The torsion has been found to be both clockwise and counterclockwise. There is the usual picture of strangulation with damage to the blood vessel walls and extravasation of blood into the tissues. When the area involved is great, the abdomen usually contains free bloody fluid. Infection is usually not present except as an invader to a point of lowered resistance. In none of our cases was there supuration present. At operation, a bluish black mass is found, covered by the surrounding structures which are adherent to it by a plastic exudate. In an older lesion the involved omentum becomes completely gangrenous. If left alone, this either would be absorbed¹² or would result in an abscess,¹³ depending upon the size of the piece of omentum involved.

In two of the cases involving an epiploic appendage, torsion was not demonstrated at operation. In the earliest case there was an inflamma-

PRIMARY ACUTE EPIPLOITIS

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THE TERM epiploon is applied not only to the great omentum, but also to the gastrocolic omentum, the gastrohepatic omentum, and the numerous epiploic appendages found on the large intestines. Acute epiploitis is primary when there is no known etiology. When the inflammatory process is the result of the epiploon's being caught in a hernial sac, or involved in the adhesions of a previous operation or adjacent diseased organ, it is considered secondary.

Eitel,¹ in 1899, was probably the first to describe a case of primary acute epiploitis. His case involved the great omentum and was reported as a rare tumor of the omentum. Baldwin's² report of a case in 1902 is said⁴ to be the first reported in this country. In more recent years there have been numerous case reports either under the term acute epiploitis or primary torsion of the omentum.

INCIDENCE

Cowell,⁵ in a review of the subject in 1925, found only 18 cases of primary torsion of the omentum. Barsky and Schwartz⁶ were able to find only 62 cases in the literature prior to 1937. It was therefore thought that it would be worth while to report and discuss 13 cases of primary acute epiploitis.

Eleven of these 13 patients were operated upon in the University Hospital during the fifteen years from 1922 to 1937. During that period there were approximately 30,000 patients admitted to the general surgical service. It would seem, therefore, that the disease is probably more common than one would suspect from a review of the literature. The other 2 cases included in this report were seen by the senior author in other hospitals. Eight of the 13 patients were males. The age varied from 20 to 62 years. There would seem to be no reason that the condition should be confined to any sex or age group. It is notable, however, that there are no children in this series. It has occurred in a child 3 years of age.¹⁶

ETIOLOGY

Theoretically, primary acute epiploitis could result from (a) strangulation by torsion of the epiploon, (b) interference with the blood supply by embolus or thrombosis, or (c) bacterial invasion of the epiploon through the circulation or from the adjacent intestinal tract. The first of these possibilities was found to be the causative factor in all of the

cases involving the omentum herein reported. Torsion could be demonstrated in only 1 of the 3 cases involving epiploic appendages. In the other 2 cases the etiology was not known. The epiploon had the appearance of being involved in an inflammatory process, but it could not be demonstrated to have come from the adjacent colon.

The etiology of the torsion is unknown. In one of our cases the pain started suddenly, as the patient turned over in bed. Numerous etiologic possibilities have been suggested in the literature:

1. There is sudden rotation of the body or violent exertion.^{5, 6} Only one of our patients gave such a history.

2. There is often a congenital malformation of the omentum^{8, 9} so that the part involved is long and narrow and therefore easily twisted on itself.

3. The anatomic arrangement of the vessels may be such that the long tortuous veins twist around the short arteries as the omentum swings from the transverse colon.⁶

4. Venous thrombosis may be the first lesion.¹¹ The veins would then become distended and would easily rotate around the arteries. Thrombosis of the vessels is always found at operation, but it cannot be demonstrated that it was present before the torsion.

5. An inflammatory process starts first⁷ and the torsion follows as the heavy inflamed omentum swings from the unaffected area.

6. The omentum, heavy with fat, is a good subject for torsion, as it swings from the transverse colon. Farr and Bachman¹¹ have suggested that torsion is more apt to occur in well-nourished individuals. This has been our experience.

PATHOLOGY

The cases involving the omentum herein reported are all samples of primary torsions resulting in acute epiploitis. It seems likely, therefore, that the torsion is the original incident and that thrombosis and strangulation follow this. The torsion has been found to be both clockwise and counterclockwise. There is the usual picture of strangulation with damage to the blood vessel walls and extravasation of blood into the tissues. When the area involved is great, the abdomen usually contains free bloody fluid. Infection is usually not present except as an invader to a point of lowered resistance. In none of our cases was there supuration present. At operation, a bluish black mass is found, covered by the surrounding structures which are adherent to it by a plastic exudate. In an older lesion the involved omentum becomes completely gangrenous. If left alone, this either would be absorbed¹² or would result in an abscess,¹³ depending upon the size of the piece of omentum involved.

In two of the cases involving an epiploitic appendage, torsion was not demonstrated at operation. In the earliest case there was an inflamma-

tory reaction in the fatty tissue of the epiploic appendage, so that it was red and injected and covered with a whitish exudate. In the case of longer duration, the epiploic appendage had assumed a bluish black color and was completely surrounded with omentum.

In the cases in this series there were found three varieties of primary acute epiploitis from the clinical standpoint, that involving (1) the entire greater omentum, (2) a small part of the omentum, or (3) one of the epiploic appendages. Of the cases herein reported, two fall in the first group, three in the third group, and the remainder in the second group.

SYMPTOMS

Abdominal pain was the only constant symptom found in these cases of primary acute epiploitis. The symptoms were not diagnostic and differed in no respect from those frequently seen in acute appendicitis. In 5 instances the pain was generalized and later localized. It is significant, however, that in 7 of the 13 cases the pain was localized from the start and remained so.

Nausea and vomiting were uncommon. Only 4 of the 13 patients vomited. Mullen¹⁴ has reported that vomiting frequently preceded the pain in torsion of the omentum, but this was not the case in this series.

The severity of the pain undoubtedly depends largely upon the size of the strangulating epiploon. In the patients with the entire omentum involved, the pain was severe. One patient was operated upon within five hours of the onset of pain. On the other hand, when a small portion of the omentum or an epiploic appendage is involved, the pain is not severe. Thus these patients reach the surgeon as a rule after a considerable delay. One patient in this group went seven days, and the average was about three days.

FINDINGS

The physical findings depend upon the extent of the pathology. Tenderness was present in all cases. There was some rigidity in all but 3 patients. Of the 13 patients, 6 had a palpable mass. Several others were so rigid that the mass could not be palpated. The findings were on the right side of the abdomen in 10 of the 13 cases. In 6 instances, the findings were definitely in the right lower quadrant.

The blood count was helpful only in indicating the presence of inflammation. The W.B.C. was under 10,000 in only 1 instance. The highest was 16,500.

The patients had very little fever, as a group. The highest temperature upon admission to the hospital was 100.3°. The temperature was below 99° in 7 of the cases reported.

DIAGNOSIS

The diagnosis was made preoperatively in only 2 of the cases. These were both on the left side and had a small tender mass palpable. The

usual diagnosis in these cases is acute appendicitis. This was true in 8 of this series. When a mass was palpable, it was thought to be an appendical abscess. In 2 instances, where the pathology was in the right upper quadrant, the diagnosis was acute cholecystitis. When a large portion of the omentum is involved and the patient is seen early, the findings may simulate those of a ruptured ulcer.¹⁰ A mass of twisted omentum in the flank has simulated kidney pathology.¹⁵

The effort to make the diagnosis of primary acute epiploitis preoperatively is a matter of academic interest. It is true that one may often suspect the diagnosis, but it is impossible to be certain. It is sufficient to make the diagnosis of an acute surgical abdomen and to localize the pathology. To attempt to diagnose a strangulation of a small bit of omentum and thus avoid operation is a hazardous procedure. In this respect, it may be similar to the diagnosis of acute mesenteric lymphadenitis in children. The diagnosis is often made and proved to be correct at operation, but one cannot be certain enough to avoid operating for appendicitis. To depend upon a nonoperative diagnosis of this sort sooner or later will lead to trouble from a ruptured appendix.

TREATMENT

The treatment of primary acute epiploitis is resection of the involved epiploon. The diseased tissue is usually surrounded by and adherent to the adjacent structures by a plastic exudate, except in the early cases. It is easily separated from the surrounding structures by finger dissection.

In 2 instances in this series, a resection of the omentum was not done. In one case the pain stopped suddenly before operation and the omentum was found at operation to have become untwisted. In a second case the omentum was untwisted at operation and was obviously viable. This latter procedure is advised against because of the danger of an embolus¹⁷ from thrombosed vessels. Thus, the omentum should not be untwisted unless it can be demonstrated that even thrombosis is not as yet present.

It is undoubtedly true that when only a small segment of omentum is involved, spontaneous recovery may occur by absorption of the necrotic material. It is also probable that if absorption does not occur and an abscess develops, it will be well walled-off. For this reason, no doubt, Schragar and Bergen¹⁸ have advocated nonoperative treatment at first, with late drainage of the abscess should it occur. This we consider poor surgical practice, especially since a positive diagnosis cannot be made before operation.

RESULTS

The results of surgical excision of the inflamed epiploon are uniformly good. These patients run the usual risks of the complications

TABLE I

AGE	DURATION OF SYMPTOMS IN DAYS	PAIN LOCALIZED FROM START	VOMITING	TENDERNESS	RIGIDITY	PALPABLE MASS	LOCATION	W. B. C.	PREOPERATIVE DIAGNOSIS	OPERATIVE FINDINGS
47	7	x		x	x		RUQ*	12,300	Acute gall bladder	Inflamed epiploic appendage
62	1/4			x			Right of umbilicus		Acute appendicitis	Entire omentum recently untwisted
20	5			x	x	x	RLQ	14,500	Appendical abscess	Torsion right half omentum; free bloody fluid
47	4		x	x	x		RLQ	11,000	Acute appendicitis	Torsion right half omentum; free bloody fluid
40	2	x		x	x		RUQ		Acute gall bladder	Torsion part of omentum; gangrenous
27	3			x	x	x	Left of umbilicus	14,800	Acute epiploitis	Torsion part of gastrotocolic omentum
37	1	x		x	x		RLQ	12,000	Acute appendicitis	Torsion small part of omentum
41	2	x	x	x	x	x	RLQ	16,500	Appendical abscess	Torsion right half of omentum
30	1			x			RLQ	16,500	Acute appendicitis	Torsion small part of omentum
20	1	x		x			Right of umbilicus	9,700	Acute appendicitis	Torsion entire omentum; bloody fluid
23	2	x	x	x	x		RLQ	14,800	Acute appendicitis	Torsion of epiploic appendage
38	4	x		x	x	x	LLQ		Diverticulitis	Inflamed epiploic appendage
40	3		x	x	x	x	LLQ			

*RUQ, right upper quadrant; RLQ, right lower quadrant; LLQ, lower left quadrant.

and catastrophes of surgery naturally. One patient in this series died of postoperative pneumonia. The abdomen was clean at autopsy. In none of the patients in this series had the pathology progressed to abscess formation. In such an event the prognosis should be good with surgical drainage, and the course of events similar to that seen in an appendical abscess.

The patients in this series have been followed from three months to fifteen years and in no instance has there been a recurrence of the trouble.

SUMMARY

1. Primary acute epiploitis is an uncommon condition of which thirteen cases are herein reported.
2. The diagnosis of primary acute epiploitis should be made, only to be confirmed at operation.
3. The treatment is excision of the inflamed epiploon.

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ISOLATED INJURY OF THE MESENTERY WITHOUT PERFORATION OF THE ABDOMINAL WALL

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ISOLATED injury of the mesentery without perforation of the abdominal wall is so rare that it seems worth while to report such a case, if only so that it may be on record.

In 1920 Prutz¹ could collect only 36 cases. Eighteen of these were operated upon, 8 dying; in 18 not operated upon, all died.

By 1936 Mandillon and Poinot² were able to review 70 operated cases and added 3 of their own. From a mortality of 57 per cent they conclude that the prognosis depends mainly upon the time elapsing before operation, the extent of the injury, and the degree of shock.

CASE REPORT.—Jackson Memorial Hospital No. C-7097. On Sept. 7, 1937, at about 6:00 P.M., a 2-year-old white girl was playing beside a 4 foot wall built of 4 by 8 inch concrete blocks between which the cement had not hardened. Each block weighed approximately ten pounds. When a 12-year-old girl leaned over this wall to pick up the child, the wall collapsed and the baby fell beneath girl and blocks. Vomiting occurred at once and in about fifteen minutes there was an involuntary stool. The baby retained consciousness and shortly began to cry. She was given a hypodermic (morphine?) by a physician and promptly went to sleep. About 1:00 A.M. she awakened screaming so was taken to the hospital.

Physical examination at 2:00 A.M. revealed a normally developed and well-nourished white female of about 2 years of age, who presented a picture of acute shock: thirst, marked pallor, great restlessness; pulse, 160 plus, very weak; respirations, 32 to 40, shallow and grunting; profuse sweating. The abdomen showed several small contusions over the upper half and was tense and did not move with respiration; definite muscle spasm approaching rigidity, especially in upper left quadrant; extreme tenderness throughout, but most marked in upper left quadrant; no peristaltic sounds heard; shifting dullness in the flanks. Rectal examination revealed fullness and tenseness in the cul-de-sac. Heart and lungs presented no abnormalities. Blood pressure, 88/50; voided urine, negative; R.B.C., 4,150,000; hemoglobin, 71 per cent; W.B.C., 27,700; polymorphonuclears, 86 per cent. Up-right x-ray of the abdomen showed an intact diaphragm and no subdiaphragmatic gas.

Diagnosis.—Acute shock, intra-abdominal hemorrhage, most probably from ruptured spleen. Antishock treatment, including a transfusion of 200 c.c. of citrated blood, so relieved the condition of acute shock that it was felt the baby could stand operation.

Operation.—At 4:00 A.M., under drip ether anesthesia, the abdomen was opened through an upper left rectus incision. A small hemorrhagic area was encountered in the muscle, apparently ecchymosis from the trauma. On opening the peritoneum, free bright blood escaped, suction recovering 200 c.c., besides a quantity

of clots eventually sponged out. The spleen, liver, diaphragm, and anterior wall of stomach were uninjured. There was no free blood in the lesser sac. The omentum, colon, and mesocolon were intact. Exploration of the small intestine and its mesentery revealed a laceration in the mesentery through both leaves at approximately its midportion. This laceration was about 15 cm. in length, beginning 1 cm. from the posterior attachment and extending to 1 cm. from the intestine. There were many freely bleeding points, all apparently venous, as no spouting points were observed and the pulsations of an artery could be seen in the edge of the rent. The adjacent intestine was healthy looking with moist, glistening serosa so it was felt that its circulation was not impaired. All bleeding points were tied and the laceration repaired by opposing the peritoneal edges on both sides with interrupted sutures, no through-and-through sutures being placed. The abdomen was closed in layers without drainage.

The postoperative course, though a bit stormy at first, caused no real concern at any time and the baby was discharged on Sept. 18, 1937. She has been seen at frequent intervals and never have any ill effects of the injury been noted. Now, fourteen months later, she is not constipated and is normal for her age in every way.

COMMENT

This case presented an interesting diagnostic problem, both preoperatively and at operation. The picture was certainly one of intra-abdominal hemorrhage. With hollow viscera and kidneys apparently ruled out, rupture of liver or spleen seemed most likely. Location of area of greatest tenderness and of greatest spasticity in left upper quadrant pointed most logically to the spleen.

The described injury might easily be overlooked in the event of first finding other injury; this could account for otherwise unexplained deaths following trauma to the abdomen.

If unoperated recovery from such injury should occur, the circulation to a loop of intestine might be so impaired as to cause a stenosis,³ possibly so long afterwards that history of trauma could not be elicited.

Operation as soon as the condition of the patient warrants it is the undoubted treatment, and, in view of the reported 57 per cent mortality, is obviously often delayed too long.

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RHABDOMYOSARCOMA

REPORT OF CASE PRESENTING UNUSUAL FEATURES WITH REFERENCE TO AGE, RACE, SITE OF ORIGIN, AND MANNER OF GROWTH

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RHABDOMYOMATOUS tumors are usually found in young persons and children in such positions as the heart wall, bladder, vagina, kidney, esophagus, and uterus. These tumors contain cells of many varieties and among them are found atypical, striated muscle fibers. However, it is unusual to find a tumor composed exclusively of muscle tissue and the admixture is often with such constituents as cartilage, loose cellular connective tissue, myxomatous areas, and even epithelial structures. The suspicion, therefore, is aroused that the rhabdomyomas are closely related to the mixed tumors or teratomas.¹ Rhabdomyomas of the skeletal muscles are rare and of the 18 cases reported up to 1913, Kuttner² rejected 6 and reported the others as questionable. A search of the tumor registry of the Army Medical Museum by one of us (J. M. F.) revealed several authentic cases in which the neoplasm originated in a skeletal muscle. None of these, however, arose from the sternocleidomastoid muscle which was the location of the tumor reported here.

CASE REPORT.—F. D., male, colored, aged about 75 years, entered the hospital on Oct. 18, 1938, complaining of a large tumor mass on left side of neck. The patient did not appear to be acutely ill and his chief difficulties arose from inability to rotate his head and from respiratory embarrassment due to pressure on the trachea by the tumor.

Family History.—Father had "lumps on neck for years that Doctors called scrofula." This patient, however, died from an attack of typhoid fever at the age of 66 years. The family history otherwise was irrelevant.

History of Present Illness.—The patient had enjoyed excellent health all of his life. He stated that in the region of the present neoplasm, there had existed a small nodule about the size of a hen's egg for about fifty years. About four months ago this had begun to enlarge without accompanying pain and remained symptomless until its bulk mechanically interfered with head rotation and respiration. No history of trauma preceding this sudden activation of the tumor could be elicited.

Physical Examination.—There was a tumor mass about the size of a grapefruit lying to the left of the midline of the neck (Fig. 1). The overlying skin was smooth and shiny. The neoplasm beneath was densely adherent to the skin and to surrounding structures. The mass was hard and nodular, irregular in outline, and had no signs of fluctuation.

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The borders of the tumor were roughly mapped out to be the ramus of the mandible above, the sternoclavicular angle below, the posterior auricular space posteriorly, and anteriorly the anterior belly of the right sternocleidomastoid muscle.

Aside from a mild systolic murmur and arteriosclerosis, the remainder of the physical examination was essentially negative.

Radiologist's Report.—Nov. 5, 1938 (Dr. Frank Wrenn), x-ray of chest showed: The right lung was apparently clear throughout. The left lung showed a consolidated area in the midportion. This was not sharply margined, but was strongly suggestive of a metastatic lesion.

Operation.—The mass was exposed by a longitudinal incision under local anesthesia. There was no suggestion of encapsulation and no line of cleavage could be determined; therefore, it was necessary to dissect the tumor free from the surrounding structures. As vascularity was quite marked, the amount of bleeding caused by this procedure was considerable.



Fig. 1.



Fig. 2.

Fig. 1.—Tumor mass in neck. Nodular characteristics apparent in this photograph.

Fig. 2.—Excised specimen. Note three distinct zones. The upper contains the calcified nodules; the middle is dense and shows cartilage-like material interspersed with rosettes of soft, pink tissue. The lower zone is composed of very soft, friable tissue, so necrotic that some of it washed away in the fixing solution.

Gross Examination of Tumor.—The excised mass weighed 1,100 gm. and measured 17 by 11 cm. It was nodular, dusky red in color, and the outer surface contained a number of tabs of connective and normal-appearing muscle tissue. The cut surface was bathed in glairy mucus and showed a wide variation in structural detail. (Fig. 2.) It was apparent that three distinct zones could be classified. The upper contained several nodules of bony hardness which required the use of a saw to execute their division.

In the central zone the tissue was of a soft cartilaginous texture, yellowish in color. Into this were inset several pink rosettes of muscle-like substance, the radiating arms of which finally blended and were lost in the cartilage frame. In

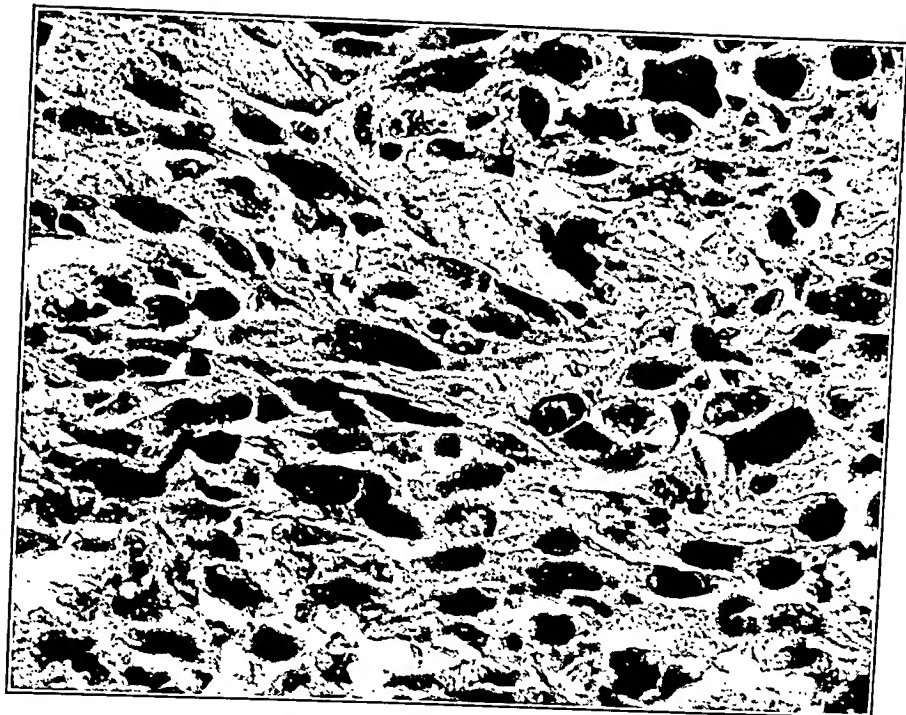


Fig. 4.

Fig. 4.—High magnification photomicrograph, showing striation and vacuolization of nuclei. In the lower central area a typical "spider cell" can be seen. Due to reproduction of picture, some of the details have been diminished.

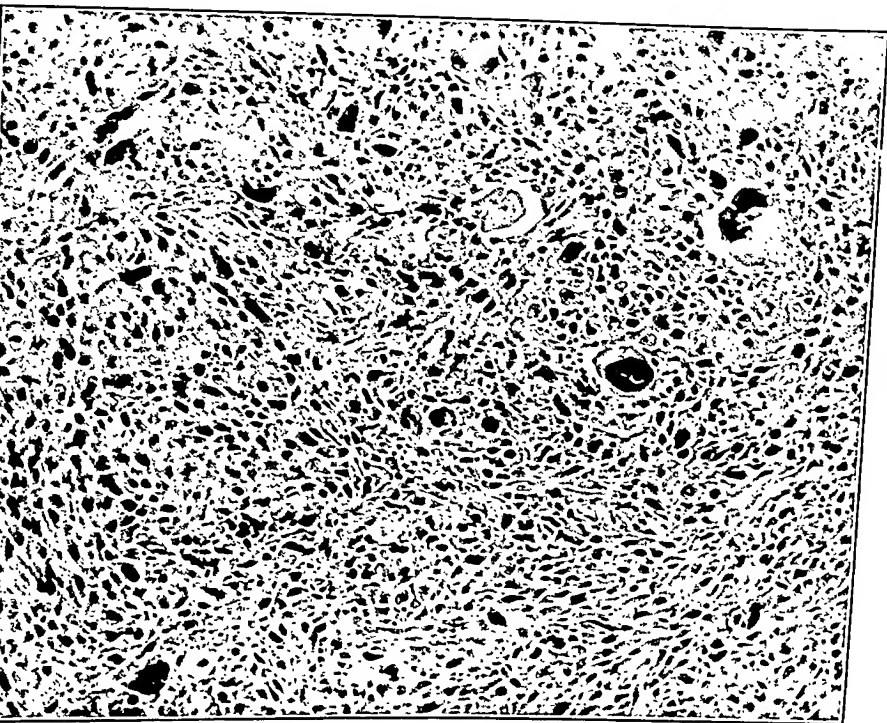


Fig. 3.

Fig. 3.—Photomicrograph showing irregular arrangement of fusiform, acidophilic cells, with liberal sprinkling of bizarre giant cells. Fig. 4.—High magnification photomicrograph, showing striation and vacuolization of nuclei. In the lower central area a typical "spider cell" can be seen. Due to reproduction of picture, some of the details have been diminished.

the lower zone the tissue was very soft and friable, so much so, in fact, that portions of it washed free in the fixing solution.

Microscopic Examination.—Sections cut from the bony hard nodules of the superior pole failed to show evidence of ossification. Only hyalinization was demonstrated. Blocks cut from the cellular areas varied somewhat in their general architecture, but the picture had an essential sameness, showing irregularly arranged strands and masses of acidophile, fusiform cells separated by a scant, hyalinized stroma. (Fig. 3.) In many instances longitudinal striation was marked and in a few cases transverse striation could be demonstrated. Liberally sprinkled among these fusiform cells were bizarre giant cells, which were more plentiful in some areas than in others. Some of these giant cells showed striation and vacuolization of nucleus, giving them all of the characteristics of the "spider cell" described by Ewing.³ (Fig. 4.)

Diagnosis.—*Rhabdomyosarcoma.* (Sections were sent to Drs. James Ewing, A. C. Broders, Edgar A. Pund, Kenneth Lynch, and J. E. Ash, with the request that an opinion be given. In each instance these authorities concurred with the diagnosis made by us.)

Postoperative Progress.—In the six weeks that have elapsed since operation the patient's course has been steadily downhill. He has grown gradually weaker until he remains in bed all of the time. Sleeplessness has to be combatted by use of strong sedatives. Cough is very bothersome and considerable mucus is expelled. The site of operation is densely edematous and it is believed that there is a beginning local recurrence of the tumor.

Radiologist's Report.—Dec. 20, 1938 (Dr. Frank Wrenn): In the right lung, just above the diaphragm, there is a round, opaque shadow about 2 cm. in diameter. In the left lung there are several round, opaque shadows throughout the lower lobe, varying from 0.5 to 3 cm. in diameter. In the upper lobe there is one similar shadow about 2 cm. in diameter. These shadows are interpreted as being metastatic lesions from a new growth. The development has been very rapid since the report of Nov. 5, 1938.

COMMENT

A rhabdomyosarcoma is reported which originated in the left sternocleidomastoid muscle of a colored man 75 years of age. We can find no record of a similar tumor arising in this site; likewise, no record can be found of this neoplasm appearing in the skeletal muscles in the colored race.

The age of the patient presents a most unusual aspect, and the fact that the tumor lay dormant for more than fifty years and then suddenly sprang forth in full malignancy appears to lend support to the theory that rhabdomyomas are closely related to the mixed tumors or teratomas.

We wish at this time to express our gratitude to the several eminent authorities who so graciously aided in confirming the diagnosis. We are also indebted to the courtesy of Lieut. Col. J. E. Ash, Medical Corps, U. S. Army, for supplying photomicrographs and to Dr. Frank Wrenn and Miss Fronde Stewart, of the Department of Radiology of the Anderson County Hospital, for their gracious aid in x-ray studies and in preparing photographs used in illustrating this article.

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VENOUS MESENTERIC OCCLUSION

A CLINICAL DISCUSSION AND EXPERIMENTAL STUDY

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MESENTERIC vascular occlusion and mesenteric thrombosis are terms which, as used clinically, describe those disorders in which an obstruction of the mesenteric vessels is present, but in which a direct occlusion of the lumen of the gut itself is not associated. In several conditions, as in volvulus or intussusception, the direct occlusion of the mesenteric vessels which may accompany obstruction of the gut lumen may cause a more fulminating picture than gut lumen obstruction itself. But by clinical custom, the mechanical features referring to gut lumen obstruction dominate the diagnosis. In other words, pathologically speaking, mesenteric vascular occlusion or mesenteric thrombosis occurs sooner or later in several conditions ordinarily listed under the heading of intestinal obstruction; but in the clinical world we have come to associate the terms predominantly with a particular syndrome. This syndrome for our purpose may be described aptly by a quotation from one of our popular textbooks: "Symptoms are sudden, violent, diffuse abdominal pain with collapse, sub-normal temperature, and signs of ileus.¹ There is leukocytosis, a late temperature, palpable mass, evidence of free fluid, and early peritonitis." Further quotations from medical and surgical textbooks could be cited to illustrate that this fulminating picture is the one usually associated with the terms mesenteric occlusion or mesenteric thrombosis. However, there is some textbook mention of a more slowly progressing occlusion. And a number of writers, including Larson, Meyer, Douglas, Ochsner, Cave, Held, and Goldbloom, and one of us have mentioned or discussed in the journals a slower more deceptive type. Nevertheless the clinical conception of mesenteric vascular occlusion is a somewhat inadequate one, frequently not taking into full cognizance the varying manifestations and possibilities which the clinical term implies. Some of the confusion attendant upon the subject is illustrated in the following quotation from Meyer: "... more detailed information is necessary to enable one to determine positively whether or not a segment of bowel will recover function or if changes leading to death from toxemia or gangrene will occur. In Garcia's case there was a grey color, lack of tone, dilatation of the bowel over a large area, yet recovery occurred promptly without resection. In Penninger's case only one foot of bowel appeared anemic and

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reacted sluggishly to stimulation; no resection was done and at post mortem six days later this segment was found to be gangrenous. In one of Davis' cases the entire small bowel seemed gangrenous, yet recovery occurred without resection, while in one of Cabot's cases the color seemed to return but the bowel was found to be gangrenous the next day. Loop had a similar experience.'⁶

In this presentation we will discuss only venous occlusions in which the lumen of the gut is *not* obstructed. When venous obstruction occurs in closed loops, the rapid collection of fluid and gas within the loop secondary to a pure venous occlusion brings about rapid loop distention and undoubtedly rapid secondary interference with arterial supply. Since much experimental work has been done by others with the closed type of loop, we would stress the difference in the pathology of the two types and the fact that we refer here to unobstructed loops.

In 1935 one of us pursued experimental and clinical observations directed at more clearly identifying the slower more deceptive clinical course which may be associated with a pure venous mesenteric occlusion in which the gut lumen remained unobstructed.² At this time we discussed the etiology of this condition, and upon the basis of our own clinical and experimental observations as well as some case reports of others, we made the following statement regarding the symptoms of a certain type of venous mesenteric thrombosis: "Since venous mesenteric thrombosis may occur as a complication of various conditions . . . it is obvious that the picture may be complicated by various elements of pathology. Generally speaking, however, except in that type of venous mesenteric thrombosis initiated for example by sudden volvulus or intussusception, the onset and course would seem to be relatively slow, and initiated by pains of a moderate colicky nature. Two of our case histories here reported and two other similar histories of cases found in the recent literature, are particularly interesting as regards the several days' duration of symptoms before the victims seem to have given themselves particularly serious consideration. Another striking symptom in the syndrome of this disease is the disproportion of the abdominal tenderness and the duration of symptoms, to the abdominal rigidity. The abdomen is usually widely and definitely tender to deep palpation and the abdominal rigidity is not nearly as marked as one might expect it to be when the possible duration of the complaint and definite tenderness are considered. The normal leucocyte relationship is only moderately disturbed in the early stages, but is markedly distorted later. An engorged intestinal wall may or may not be felt as a palpable mass. Occult blood is uniformly present in the stool and bowel movements continue, dark and soft to liquid in nature. Dark brown 'coffee ground' like vomitus may supervene. The temperature range in the uncomplicated picture is low. Intestinal 'fluid levels' are usually absent. Unless the possibility of the disease is kept in mind it will be invariably

very difficult to recognize it as a definite surgical condition in its earlier stages when surgery should offer a very excellent prognosis. Intestinal obstruction, appendicitis, peritonitis, peptic ulcer, lead colic, 'simple' enteritis, cholecystitis, gastritis, typhoid fever, are among the diseases most likely to be confused by the expert."

We demonstrated in a small series of experiments accompanying this previous discussion that occlusion of the veins alone in segments of gut up to 25 cm. in length would cause in many instances sufficient edema, discoloration, and sogginess of the gut to indicate that gangrene was present or would supervene; and that, with this condition existing, a recovery of the animal might occur. We showed that in this small series, larger areas of gut could be involved in a pure venous occlusion with recovery of the animal ensuing than was possible when the arteries were involved. We concluded that in rather marked venous occlusions arterial supply at times remained sufficiently unimpaired and the gut wall sufficiently undamaged that a collateral circulation through the omentum and adjacent mesentery in conjunction with lymphatics, eventually would establish sufficient circulation to allow clinical recovery. Further thought upon this subject of venous mesenteric occlusion and comments of others similar to the quotation from Meyer above relative to confusion regarding it stimulated our curiosity and we decided to carry out some additional simple experiments. We concluded previously that, even though some of our experimental animals recovered completely, resection of the gut was, as a rule, probably the safest procedure to follow when venous mesenteric occlusion was recognized.

We are following two clinical objectives in this presentation. One is to attempt to establish more definite clinical concepts of venous mesenteric occlusion and to contrast venous with the more frequently described but less frequently occurring arterial occlusion. The second objective is to attempt a more precise correlation of the pathology of venous occlusion with clinical manifestations, prognostic and therapeutic indications.

EXPERIMENTAL PROCEDURE

The experimental element of this paper has resolved itself in one sense perhaps to determining the extent to which collateral circulation will establish itself in venous occlusions. But one following this subject closely can see that an attempt to surmise at the operating table as to when and when not circulation might become sufficiently established before gangrene or destruction of the gut occurs, might be more difficult than appears on first thought. As most experienced surgeons know, a number of tests directed at determining the viability of the gut at the operating table have been described and used with somewhat questionable success.

As far as we have been able to determine, circulation within the gut of a dog is sufficiently similar to that of the human being for us to

assume that conclusions which have been reached here apply fairly accurately to human beings.

Fig. 1 diagrammatically illustrates the simple technique which we used in producing occlusion of the mesenteric veins. We selected the desired site and length of gut to be involved and placed the mesentery on a stretch with the finger at the sites selected for the ligatures. By rolling the vessels gently on the stretch over the finger, in most instances we were able to insert a needle between the artery and vein and encircle the vein with a small ligature without damage to the artery and with inclusion of very few of the lymphatic radicals. The lumen of the gut was left undisturbed. All the veins in the mesentery leading from the area to be involved were ligated at the sites of easiest election in such a manner that no venous return through the segment of involved mesentery was possible. Though we have on several occasions cut the mesentery along the gut margin between the mesenteric vessel radicals to insure severance of any minute collaterals within the mesentery, we feel that this is in most instances unnecessary. The weblike collaterals seen between the main vessel branches in the mesentery of most dogs are so small and scanty that they are incapable within themselves of producing any worthwhile collateral function in a short length of time.

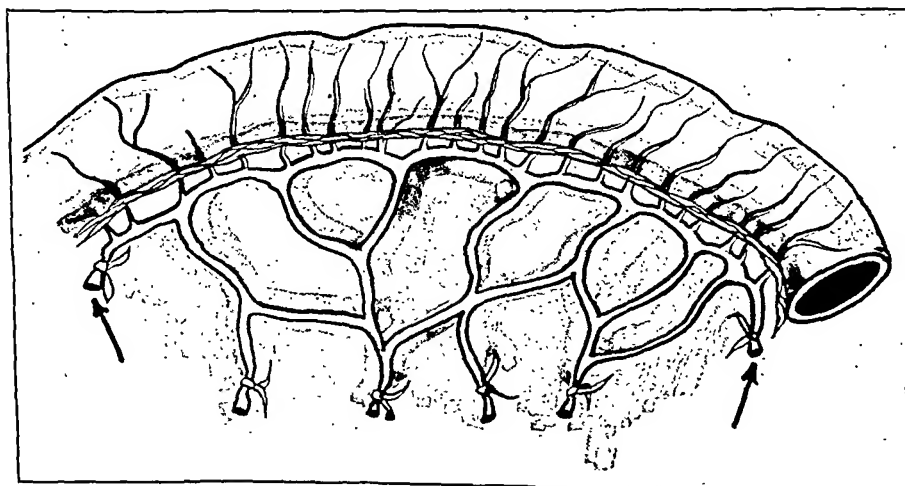


Fig. 1.—Diagrammatic illustration of method used in ligating veins to loops selected. Before loops were returned to abdomen, all were observed after ligations were completed until venous congestion supervened. Arteries and lymphatics are not shown in this diagram for the sake of clarity.

The lower ileum was the site most frequently selected, though the jejunum was sometimes used.

Following completion of the ligation, the potential sources of collateral circulation are few. Those which may be developed from structures which may later adhere to the involved gut, such as omentum, and that circulation which may develop or be carried on through adjacent un-

damaged bowel wall tissues are to be considered. The mesenteric lymphatics also are potential channels for the egress of some edema.

The degree of damage which was consistent or inconsistent with clinical recovery and arbitrary mortality percentages was determined as indicated in the accompanying tables. Other observations, reflecting possibly upon the clinical aspects of this problem, were also made.

Forty-seven animals were used in the study, though nine of these were discarded in the final analysis.

EXPERIMENTAL RESULTS AND DISCUSSION

In comparing the results of venous occlusions with arterial occlusions, it is well to remember that it has been stated that collateral arterial circulation through the tissues of the bowel wall itself can be successfully carried on over a maximum length of about 2 inches. A review of Table I shows the results of sudden venous occlusion without gut lumen obstruction in segments of small bowel 20 to 40 inches in length. In the sixteen dogs in which these lengths were used one dog may be



Fig. 2.—This is a photograph of a segment of small bowel which showed recovery following a venous occlusion. Adhesions involving adjacent structures and omentum have been separated. Though it cannot be clearly seen in the photograph, definite vessels are running within the two heavy strands clearly visible in the omentum. These vessels, as may be seen, are closely adherent to the loop and on dissection it could be demonstrated that definite collateral branches from them had established themselves in the gut wall.

said to have recovered. This animal (Dog 2, 20-inch segment) lived sixty-eight days, and, though the bowel was not completely repaired, we believe death was not due to bowel involvement. Dogs 3 and 15 lived twelve days from the onset of occlusion and at autopsy the bowels ap-

TABLE I

VENOUS OCCLUSION LOOPS (GUT LUMEN NOT OBSTRUCTED)
(20 TO 40 INCHES)

DOG NUMBER	SERIAL NUMBER	DATE OPERATED UPON	LENGTH OF LOOP INVOLVED	RESULTS	REMARKS
1	S10-D4	7/24/38	20 in.	Found dead 7/25/38	Gut black, considerable bloody peritoneal fluid; not perforated
2	S10-D7	7/25/38	20 in.	Found dead 10/1/38	Loop involved in Grade 2 adhesions to self and mesentery
3	S10-D11	7/31/38	20 in.	Found dead 8/12/38	Gut loop slightly distended; deep gray-black color
4	S10-D14	7/30/38	20 in.	Found dead 8/2/38	Loop perforated, peritonitis beginning
5	S10-D16	8/ 2/38	20 in.	Found dead 8/3/38	Loop very black; no perforations, peritonitis, or ileus
6	S10-D18	8/ 9/38	20 in.	Found dead 8/10/38	Loop very black; no peritonitis or perforations
7	S10-D28	8/18/38	22 in.	Found dead 8/19/38	Bloody fluid peritoneal cavity; no perforations; loop edematous, heavy, very dark; no peritonitis
8	S10-D15	8/ 2/38	25 in.	Found dead 8/3/38	Loop black; no perforations or peritonitis
9	S10-D23	8/11/38	30 in.	Found dead 8/13/38	Gut deep purple, distended; no perforations
10	S10-D22	8/11/38	30 in.	Found dead 8/12/38	Gut deep purple, distended
11	S10-D21	8/11/38	30 in.	Found dead 8/12/38	Loop almost black
12	S10-D20	8/11/38	30 in.	Found dead 8/12/38	Gut loop deep purple; no perforations
13	S10-D19	8/11/38	30 in.	Found dead 8/11/38	Loop very black; no perforation
14	S10-D17	8/ 9/38	30 in.	Found dead 8/10/38	Loop black; no perforations or peritonitis
15	S10-D13	7/31/38	30 in.	Found dead 8/12/38	Gut deep red in color, somewhat distended adhesions forming; not particularly edematous; no peritoneal fluid; cause of death unknown; dog apparently could have recovered
16	S10-D12	7/31/38	40 in.	Found dead 8/1/38	Loop very dark

Died within 72 hr. 13 (81.2%)

Lived 12 days 2 (12.5%)

Recovered 1 (6.2%)

Mortality 93.7%

peared to be in a condition possibly compatible with recovery. The remainder of animals in this group except two died within 72 hours. The following points are of interest: (1) The first thing of note is that ultimate recovery without surgery must be rare when segments of the small gut of 20 to 40 inches are involved in pure complete venous mesenteric occlusion even with the lumen of the gut unobstructed. Counting Dog 2 as a recovery, the mortality in this group would be 93.8 per cent. Even though this is high, it is not as high as the mortality of arterial

occlusions of this length. The latter give a 100 per cent mortality without surgery. (2) A point of special interest is the relative slowness with which the clinical manifestations occasionally may progress even in these lengthy loops in which sudden venous occlusions have occurred. In two animals (Dogs 3 and 15) it may be seen that twelve days elapsed before death occurred. This is in marked contrast to the rapid (death in twenty-four to forty-eight hours) declination which invariably follows all complete arterial occlusions of the same lengths, and is in keeping with a type of syndrome of venous mesenteric occlusion which has been described as clinically possible in human beings when even rapid or sudden venous occlusions apparently have occurred.

In Table II (segments 12 to 16 inches in length) it is seen that one dog lived sixteen days following the occlusion before dying, substantiating again the clinically slow syndrome which may occur in venous occlusions. One animal (Dog 4) died from intestinal obstruction from adhesions about the involved site; and we are disposed to count the bowel wall in this animal and in Dog 9 as compatible with potential clinical recovery. Doing this, the percentage of death is calculated as 81.8 per cent. In the remaining animals of this group, death occurred within three days.

In the eleven dogs (Table III) in which we used 10-inch segments (25 cm.) the mortality rate diminished but remained quite high (72.7 per cent). Again here it may be seen, however, that the slowness of the syndrome in these relatively short occlusions may be rather pronounced (though as seen from the tables it is frequently fulminating) and that experience with it explains the clinical manifestations and slowness of the progress that has been observed in human beings. We would mention especially the human case of Held and Goldbloom³ and two of the cases which we previously reported in which the downward progress of the patient extended over a period of one to three weeks; and in which the patients themselves had failed to promptly recognize a serious condition.¹ This is to be contrasted with arterial occlusion proper in which the usual fulminating syndrome brings the patient rapidly to the doctor and in which the condition is recognized promptly as being surgical.

Dog 4 in Table III, which had recovered completely and which was killed on the thirty-seventh day, was quite interesting. The 10-inch loop which had been involved in venous occlusion showed a most distinct demarcation and discoloration. The gut which had been involved in occlusion presented a medium dark, distinct brown, somewhat streaked color over the entire wall surface, contrasting vividly with the color of the adjacent good gut. The wall itself had recovered fairly well, though grossly some fibrosis seemed present. We assumed that the discoloration was due to pigment from the broken-down blood cells of the hemorrhagic infarction and edema which followed the venous occlusion.

TABLE II
VENOUS OCCLUSION LOOPS (GUT LUMEN NOT OBSTRUCTED)
(12 TO 16 INCHES)

DOG NUMBER	SERIAL NUMBER	DATE OPERATED UPON	LENGTH OF LOOP INVOLVED	RESULTS	REMARKS
1	S10-D37	10/11/38	12 in.	Found dead 10/13/38	Gut reddish purple; no perforations or general peritonitis
2	S10-D36	10/11/38	12 in.	Found dead 10/13/38	Gut reddish purple; no perforations or general peritonitis
3	S10-D26	9/16/38	12 in.	Found dead 9/17/38	Not perforated; black
4	S10-D31	9/19/38	13 in.	Found dead 10/16/38	Was reopened 9/26/38; Grade 2 adhesions to area, of mesentery and omentum; collateral circulation being established; adhesions freed; found dead 10/16/38 apparently from mechanical obstruction of adhesions; gut loop blue
5	S10-D39	10/24/38	13 in.	Found dead 10/27/38	No peritonitis; gut dark, necrotic
<i>Microscopic Findings</i> Hemorrhagic infarction, necrosis, or post-mortem autolysis					
6	S10-D38	10/24/38	14 in.	Found dead 10/27/38	Fibrinous exudate about loop; gut black; some fluid in abdomen; no general peritonitis or ileus
<i>Microscopic Findings</i> Hemorrhagic infarction, complete necrosis of mucosa; little inflammatory change; marked venous congestion; large saprophytic rods in otherwise normal mesenteric arterioles					
7	S10-D34	10/10/38	15 in.	Found dead 10/12/38	Loop reddish purple; no perforations
8	S10-D27	9/18/38	15 in.	Found dead 9/18/38	Free bloody fluid and gut perforated
9	S10-D29	9/18/38	16 in.	Found dead 10/11/38	Reopened 9/26/38; Grade 3½ adhesions omentum and mesentery; collateral circulation being established apparently; loop heavier, moderately deep dark red; all adhesions freed; died 10/11/38, cause unknown; involved loop definitely more blue than good gut; no perforations or peritonitis
10	S10-D35	10/10/38	16 in.	Found dead 10/26/38	On 10/24/38 dog was reopened under anesthesia. Some adhesions separated from the blue gut and animal closed; at autopsy two days later collateral circulation of omentum was being established
<i>Microscopic Findings</i> Venous thrombosis with beginning organization; dilated lymph channels; desquamation arterial endothelium probably secondary; dubious thrombosis in few arterioles; no necrosis					
11	S10-D24	8/11/38	16 in.	Found dead 8/12/38	Gut deep reddish purple; distended
Died within 72 hr.				8 (72.7%)	
Died in 16 days				1 (9.09%)	
Recovered*				2 (18.1%)	
Mortality				51.8%	

*Because of the good general condition of Dogs 4 and 9 at the time reoperation was performed, the length of time which had elapsed before reoperation, the condition of the bowel as determined by reoperation, the fact that the animals died only after reoperation and severing of all adhesions and sources of collateral circulation which had been formed, we feel fully justified in classifying these two animals as recoveries.

TABLE III
VENOUS OCCLUSION LOOPS (GUT LUMEN NOT OBSTRUCTED)
(10 INCHES)

DOG NUMBER	SERIAL NUMBER	DATE OPERATED UPON	LENGTH OF LOOP INVOLVED	RESULTS	REMARKS
1	S10-D32	9/20/38	10 in.	Found dead 9/21/38	Gut black though not markedly liquefied; no peritonitis
2	S10-D30	9/19/38	10 in.	Found dead 9/21/38	General peritonitis, gut perforated
3	S10-D46	11/ 1/38	10 in.	Found dead 11/3/38	Loop gangrenous, perforated
4	S10-D47	11/ 2/38	10 in.	Killed 12/9/38	A sharp demarcation and brown color of entire loop; some collateral circulation through omental attachments
5	S10-D44	10/30/38	10 in.	Found dead 11/2/38	General peritonitis, gut gangrenous and perforated high jejunum
6	S10-D43	10/30/38	10 in.	Killed 12/9/38	Recovery with Grade 2 adhesions
7	S10-D40	10/29/38	10 in.	Killed 12/9/38	Grade 3 adhesions; gut wall somewhat sclerotic but recovered
8	S10-D45	11/ 1/38	10 in.	Found dead 11/10/38	Segment blue but not perforated or gangrenous; no peritonitis; cause of death uncertain
<i>Microscopic Findings</i>					
					Autolysis superficial layers mucosa; no other changes of note
9	S10-D48	11/ 2/38	10 in.	Found dead 11/14/38	A few adhesions; distended and somewhat atonic; mucous membrane velvety with some exudate; no peritonitis; no ileus
<i>Microscopic Findings</i>					
					Superficial desquamation mucosa; no other changes of note
10	S10-D42	10/30/38	10 in.	Found dead 10/31/38	Dark velvet loop, some exudate over thick mucous membrane; some red thin fluid in cavity; no distention or peritonitis
<i>Microscopic Findings</i>					
					Necrosis bowel wall; some hemorrhagic infarction and inflammatory change but not marked
11	S10-D41	10/29/38	10 in.	Found dead 11/8/38	Loop adhesions; no peritonitis; cause of death uncertain; gut blue but not gangrenous or apparently greatly damaged
<i>Microscopic Findings</i>					
					Bowel wall thin; post-mortem (?) autolysis of mucosa
Died within 72 hr.				5	(45.4%)
Died 10 to 12 days				3	(27.2%)
Recovered				3	(27.2%)
Mortality					72.7%

The specimen beautifully illustrated that a sharply demarcated and definite pathologic process had occurred over 10 full inches of gut and that yet the arterial supply of the gut had been able to function to the extent that the gut had remained viable until sufficient collateral circulation became established through the gut wall, omentum, and unobstructed lymphatics to allow recovery to occur.

In nearly all animals which recovered, the omentum actually did

establish a certain amount of collateral circulation. New vessels from it could be traced directly into the gut wall itself in some instances. In two or three animals which recovered, no evidence of collateral circulation outside the gut wall itself was present; and in these animals it appeared that with the 10 inches involved collateral circulation through the tissues of the gut wall alone seemed to compensate satisfactorily.

Some microscopic studies were done and are recorded in the tables. Necrosis and desquamation of the mucosa, and hemorrhagic infarction or degeneration of the gut wall tissues occurred in those animals which died promptly. The microscopic findings of Dog 10 given in Table II illustrate, we believe, the process which occurs in those cases in which damage has been rather severe but in which recovery takes place: "Venous thrombosis with beginning organization; dilated lymph channels; desquamation arterial endothelium probably secondary; dubious thrombosis in few arterioles; no necrosis."

SUMMARY

1. Forty-seven dogs were used in an experimental attempt to establish more definite clinical concepts of venous mesenteric occlusion by procuring a more precise correlation of the pathology of venous occlusion with clinical manifestations, prognostic and therapeutic indications.

2. Clinical cases do occur occasionally in which complete venous occlusions involving 20 inches or more of small gut run a relatively slow and deceptive course as compared to arterial occlusions; and recovery sometimes may occur without surgical intervention when such lengths are involved. The lymphatics allow for the egress of some edema; tissue pressure is relieved by seepage of fluid into the intestinal canal; collateral circulation tends to become established through the omentum and other structures which adhere to the involved site. Retrograde thrombosis into the arterioles does not necessarily occur; and the function of these latter may be surprisingly persistent, even when the gut wall is severely involved in the hemorrhagic infarction of venous occlusion.

Signs and symptoms of the potentially deceptive type of syndrome in venous mesenteric occlusions are discussed briefly and references to clinical case reports are given.

3. In these experiments no therapy, surgical or otherwise, was used. The animals were given water by mouth and a regular diet. In segments of small gut (dogs), 20 to 40 inches in length in which complete pure venous occlusions were produced suddenly (gut lumen not occluded), the mortality was 93.7 per cent. One animal out of sixteen spontaneously recovered (6.2 per cent). Two animals lived twelve days, illustrating the occasional slowness of the venous occlusion syndrome as compared to the invariably rapid exodus which follows prompt arterial occlusions of the same length.

In segments 12 to 16 inches in length the mortality was 81.8 per cent; recovery, 18.1 per cent; and one animal lived sixteen days before dying.

In 10-inch segments the mortality was 72.7 per cent; recovery, 27.2 per cent; and 27.2 per cent lived from ten to twelve days; 45.4 per cent died within seventy-two hours.

4. The small gut will recover spontaneously from larger areas of hemorrhagic infarction and pure venous occlusion than is commonly appreciated. Arbitrarily speaking, however, in venous occlusions involving completely 6 inches or more of the small gut wall, resection should be done if conditions permit.

We wish to express our appreciation to Dr. Albert DeGroat for the microscopic studies made. We also kindly thank Mr. George Cowan for the courtesies he has extended in assisting our photographic department in this and many other pieces of work.

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LOCAL LESIONS PRODUCED IN MICE BY STAPHYLOCOCCUS TOXIN AND BY TOXIN- AND NONTOXIN- PRODUCING STRAINS

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STAPHYLOCOCCUS toxin, when injected intradermally in rabbits, produces necrosis in the skin.^{1, 2} Parker³ studied this lesion microscopically; however, as she states: "No attempt has been made to carry out a complete or detailed study. In the section of a lesion taken one-half hour after injection no pathological alteration is discernible except slight edema which extends through the whole corium, and a scattering infiltration with a very few polymorphonuclear leucocytes and large mononuclear cells. Section of a lesion 24 hours old shows marked evidence of inflammation and beginning necrosis."

Stookey and Scarpellino,⁴ in discussing staphylococcus infection of the skin, express the opinion that "the rapidly necrotic properties of the ulcers must be due to a powerful lytic agent. This we believe to be the exotoxin of the staphylococcus which, in our experience, is one of the most rapidly necrosing toxins elaborated by pathogenic bacteria."

It is well known that polymorphonuclear leucocytes localize about groups of staphylococci, either living or dead. This reaction is thought to be the result of positive chemotaxis. Different strains of staphylococci vary in their chemotactic action. Different species of animals also vary in their reaction to staphylococci.⁵

A lesion recently observed in the muscles of rabbits following the intravenous injection of a toxin-producing strain of staphylococci was different from those usually described as occurring locally with staphylococci. It was characterized by many necrotic muscle fibers surrounded by leucocytes. The histologic changes in the muscle were similar to those produced by staphylococcus toxin. This observation suggested that a study of the lesions produced by toxin- and nontoxin-producing strains of staphylococci might be of value in the interpretation of the pathologic lesions produced by staphylococci in the human being. The lesions produced by staphylococcus toxin in the subcutaneous tissue of mice were included in this study to compare the lesions produced by it with those produced by the organism.

MATERIALS AND METHODS

The staphylococcus toxin* used in this study contained 8,000 dermo-necrotic units per cubic centimeter at the time of its preparation. It

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*The toxin was supplied through the courtesy of Lederle Laboratories.

was diluted 1:100 with physiologic saline solution immediately preceding the inoculation. Injections of 0.05 c.c. of this diluted toxin were made subcutaneously into each side of the abdomen of twenty white mice.

The toxin-producing strain was an aureus variant from a culture obtained in May, 1933, from the pharynx of a patient with agranulocytic angina. The lethal effect of this variant on rabbits was recently reported.⁶ The ability to produce toxin was determined by the method of Biggers.⁷ The supernatant fluid, after centrifugalizing the bacterial suspension obtained from washing the 48-hour growth from an agar slant 15 by 2.5 cm., contained enough hemotoxin in 0.05 c.c. to completely lyse 2 c.c. of a 1 per cent suspension of rabbit's cells. The nontoxin-producing strain of *Staphylococcus albus* was isolated in May, 1937, from a furuncle in the nose. No lysis occurred when 0.8 c.c. of the supernatant fluid from this culture was added to 2 c.c. of a 1 per cent suspension of red cells.

The staphylococcus strains were grown on agar slants for 18 to 24 hours immediately preceding inoculation. The bacteria were washed and suspended in a physiologic solution of sodium chloride. The suspensions of the organisms were grossly turbid and brought to approximately the same concentration. Injections of 0.05 c.c. of these suspensions were made subcutaneously on each side of the abdomen of white mice. Twenty were given the suspension of the nontoxin-producing strain and twenty-six the suspension of the toxin-producing strain. A No. 27 gauge needle was used. Two mice from each of the three groups were killed after 30 minutes, 1, 1.5, 2, 3, 4, 5, 6, 8, and 10 hours. Two mice inoculated with the toxin-producing strain of organisms were killed after 11 and 12 hours. The abdominal wall in the area of the inoculation was immediately removed from all the mice and placed in a 5 per cent solution of Zenker-acetic acid. The sections were prepared and stained with hematoxylin and eosin. Select sections were stained according to Giemsa's method.

Tissue from four uninoculated mice was used for the control.

EXPERIMENTAL

Effect of Staphylococcus Toxin.—The mice inoculated with the staphylococcus toxin appeared slightly less active than the controls. All survived the effect of the inoculum and were killed. The abdominal wall in the area of the injections was macroscopically edematous and hyperemic after 3 to 4 hours. The blood vessels were dilated on the peritoneal surface. Microscopically the vessels were dilated after 30 minutes. The subcutaneous tissues were edematous at this time. The muscle in the abdominal wall showed focal hyaline and nonstriated areas and necrosis after 90 minutes (Fig. 1C). The injury to the tissue apparently did not progress after the first 2 hours. Polymorphonuclear leucocytes were the characteristic cells present. After 30 minutes these cells lined the

lumen of the dilated vessels and were present in the adjacent tissue. Only a few leucocytes were found in the edematous and necrotic tissue during the first three hours after inoculation (Fig. 2A). Many of these



Fig. 1.—A, Polymorphonuclear leucocytes are present along the wall of these vessels and in the adjacent tissue. A toxin-producing strain of staphylococci was inoculated subcutaneously 30 minutes previously. This section is separated by normal tissue from the bacteria which are not shown here. B, A portion of the same tissue as shown in A. A solid mass of staphylococci surrounds the blood vessels. There are no leucocytes present. Apparently leucocytes are lysed very quickly by the toxin. C, Necrosis of the muscle in the abdominal wall 1½ hours following the injection of 0.05 c.c. of a 1/100 dilution of staphylococcus toxin. Note the absence of a leucocytic reaction. D, Necrosis of muscle in abdominal wall six hours after injecting the same amount of toxin as in C. Leucocytes are present about the debris. (Hematoxylin-eosin, $\times 600$.)

cells during this time were pyknotic and lysed. After 6 hours the leucocytes appeared more numerous and better preserved. At this time they seemed to be in greater numbers about the necrotic muscle tissue (Fig. 1D).

Effect of the Nontoxin-Producing Strain of Staphylococci.—The mice appeared normal following the inoculation. The early lesions were

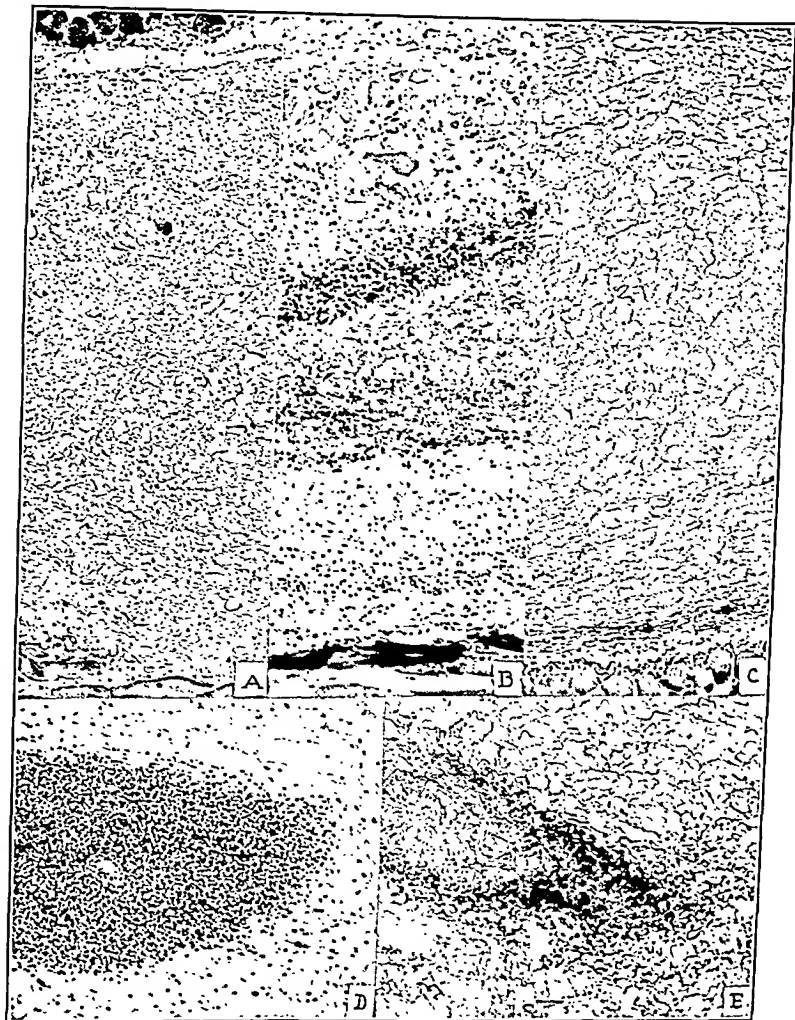


Fig. 2.—A, The tissue is edematous and few leucocytes are present. Many of the latter are degenerated. A 0.05 c.c. volume of a 1/100 dilution of staphylococcus toxin was injected 3 hours previously. B, The tissue is edematous. The area is infiltrated with leucocytes. The latter are surrounding and phagocytizing the bacteria. A 0.05 c.c. volume of the nontoxin-producing strain of staphylococci was injected 3 hours previously. C, The tissue is edematous. Only a few leucocytes are present and a majority of these appear to be injured. A toxin-producing strain of staphylococci equal to that given in B was injected 3 hours previously. D, The leucocytes have localized in the area previously occupied by the staphylococci and they have almost completely phagocytized the latter. The same suspension of organisms was given here 8 hours previously as in B. E, There are no leucocytes about this group of toxin-producing staphylococci. The same suspension of bacteria was given here as in B, 8 hours previously. (Hematoxylin-eosin, $\times 100$.)

similar to those which occurred with the toxin. The bacteria were more or less localized in the subcutaneous tissue. The muscle never showed any evidence of necrosis and the subcutaneous tissue showed only a small amount at the end of the experiment. The polymorphonuclear leucocyte was the characteristic cell in the inflammatory process. After 30 minutes these cells lined the lumen of the dilated vessels and infiltrated the adjacent tissue. As time progressed, the leucocytes appeared to migrate toward the bacteria. After 3 hours the leucocytes had collected about the organisms and infiltrated the adjacent tissue (Fig. 2B). They were phagocytizing the bacteria. After 8 hours the leucocytes had invaded the entire area previously occupied by the bacteria and practically all the latter were phagocytized (Fig. 2D). Little change occurred in the reaction during the last two hours of the experiment.

Effect of a Toxin-Producing Strain of Staphylococci.—A majority of the twenty-six mice that received these organisms were weak and would not eat after 3 hours. Four of the group died 5 to 10 hours after the injection. Pathologic studies were made only on the mice that were sacrificed.

Macroscopically, the abdominal wall in the areas injected was edematous and hyperemic after three hours. As the experiment continued, the edema progressively spread to involve the greater portion of the wall. After 6 to 8 hours the skin was pale yellow in color. Microscopically, the changes after 30 minutes were similar only in few respects to those in which the nontoxin strain of staphylococci were injected. Polymorphonuclear leucocytes were present in the tissues about the blood vessels in the areas where there were no bacteria (Fig. 1A). Only a few leucocytes ever infiltrated the zone occupied by the organisms and they apparently were destroyed very rapidly (Fig. 1B). Phagocytosis was not a conspicuous process at any time during this experiment.

Although it was impossible to completely control the site of inoculation, there seems to be no doubt that the toxin-producing bacteria invaded very quickly the surrounding tissues. The leucocytes failed to localize the organisms after 8 hours as they did with the nontoxin-producing strain of staphylococci (Fig. 2E). Extensive necrosis occurred after 12 hours. Leucocytes invaded the wall of some of the smaller blood vessels and apparently some of the latter were thrombosed. Injured and degenerated leucocytes infiltrated the tissue in the abdominal wall. Staphylococci and leucocytes were present along the peritoneal surface. The corium and the squamous epithelium were necrotic in some areas.

DISCUSSION

The local lesions which occur following the local injection of a toxin-producing strain of staphylococci are very different from those which follow the local injection of a nontoxin-producing strain. The former

are characterized by a diffuse spread of the bacteria and extensive necrosis; the latter show essentially no necrosis and complete localization of the bacteria after 8 hours.

The cellular defense of the body, in the presence of a toxin-producing strain of staphylococci, apparently can play only a secondary role. Polymorphonuclear leucocytes respond to this type of infection; however, only a few are present about the bacteria (Fig. 1B). The toxin produced by the bacteria very quickly destroys the leucocytes. The organisms apparently spread rapidly in the absence of a cellular reaction.

The presence of leucocytes about the necrotic tissue after 3 hours in those mice inoculated with only staphylococcus toxin suggests that either all the toxin unites with the tissue or that it is at least adsorbed on the tissues by this time and that the subsequent cellular reaction is the response to the debris.

Leucocytes are not a conspicuous feature about the necrotic tissue in the mice injected with the toxin-producing strain. Apparently this is the result of the destructive action of the toxin which is continually formed by the staphylococci.

Van de Velde in 1894 observed the absence of leucocytes and the multiplication of bacteria in the pleural exudate following the local injection of a virulent strain of staphylococci in the rabbit.⁵ A similar process apparently occurs in the subcutaneous tissue of mice following the local inoculation of a toxin-producing strain of staphylococci. Necrosis of muscle 30 minutes after the injection of the toxin-producing strain of staphylococci shows the rapidity with which this bacterium can produce toxin. This necrotic tissue, in the absence of phagocytic leucocytes, apparently serves as an excellent medium for the growth, multiplication, and spread of staphylococci.

The demonstration of the local effect of staphylococcus toxin produced *in vivo* and the presence of lesions produced by toxin in other organs⁹ suggest that specific antitoxin is indicated in the treatment of lesions produced by some strains of staphylococci. Recently it was shown that staphylococcus antitoxin given intravenously to rabbits prolonged the period of survival following the intravenous injection of the same toxin-producing strain of staphylococci as used in this experiment.⁶

SUMMARY

The lesions which follow the local inoculation of a toxin-producing strain of staphylococci are very different from those which follow the injection of a nontoxin-producing strain of staphylococci.

Staphylococcus toxin is formed very rapidly *in vivo* and apparently unites quickly with striated muscle and leucocytes. It necrotizes muscle and lyses white blood cells within 30 minutes.

The organisms from toxin-producing strains of staphylococci apparently grow, multiply, and spread very rapidly through the necrotic tissues.

Polymorphonuclear leucocytes are the characteristic cells present in the tissues when either staphylococcus toxin or a toxin- or a nontoxin-producing strain of staphylococci is inoculated into the subcutaneous tissue of mice. Leucocytes phagocytize the bacteria very quickly from nontoxin-producing strains of staphylococci. Only a small amount of phagocytosis occurs, however, with a toxin-producing strain.

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THE IMPORTANCE OF EARLY STUDY FOR METASTASES IN TUMORS OF THE BLADDER

ILLUSTRATIVE CASES

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WE BELIEVE the incidence of clinically recognizable metastases from bladder tumors is distinctly higher than one would gather from a study of the literature. References to metastases from bladder tumors are to be found in isolated case reports, which tend to emphasize the rarity of the condition and give the impression that, when metastases do occur in carcinoma of the bladder, they occur very late or in the end stages of the disease. A few reports, based on autopsy findings, have been thought to overestimate the frequency of metastases from bladder tumors. It generally has been felt that carcinomatosis is found much less often than in cancer of the breast, stomach, and prostate.

Cunningham (1931) analyzed 411 cases of carcinoma of the bladder reported in the literature and found metastases in 32.3 per cent. Spooner (1934) analyzed autopsy records in 163 cases of bladder tumor. Metastases occurred in 49 (29 per cent), but the clinical diagnosis of metastasis was made in only 4 cases. In 24 cases the symptoms were of less than two years' duration, and 19 patients had symptoms for less than one year.

Colston and Leadbetter (1936) found in 98 cases of infiltrating tumors of the bladder, which came to autopsy, 61.1 per cent which showed metastases. Many of these represented the end stage of cancerous disease of the bladder, but a considerable number did not, since many patients had been operated upon for extensive removal of the tumor. After retroperitoneal lymph gland involvement, the most frequently involved organs were the liver, lungs, and bone. Bone involvement was of frequent occurrence; namely, 18.1 per cent in 57 cases. This is noteworthy because from reports in the literature metastasis to bone is considered rather infrequent. The liver was involved in 41.8 per cent, and the lungs in 25.4 per cent. Involvement of the lymph glands was common, 72.7 per cent. The remainder of the metastases were distributed through a variety of organs.

In view of the high incidence of metastases to the lungs and bones, it is clear that x-rays of these organs should be a routine procedure in cases

of bladder tumor. Careful palpation of the abdomen should be made to outline any enlargement or irregularity of the liver, and in selected cases exploratory laparotomy should be considered in an attempt to ascertain the status of liver enlargement as well as to palpate for enlarged glands in the retroperitoneal and iliac regions. Intravenous urography is of value in determining, by filling defects, the location and size of tumors within the bladder, and particularly in demonstrating lesions of the upper urinary tract resulting from tumors of the bladder.

Such careful studies for metastatic lesions become increasingly important as more radical surgery for cancer of the bladder is attempted. Although there is widespread use of high voltage x-ray therapy in the treatment of both early and late cases of carcinoma of the bladder, regardless of the grade of malignancy, opinion is divided in regard to the efficacy of such treatment. We believe that radical surgery still offers the best hope of ultimate cure in suitable cases. In infiltrating tumors involving the base and vesical orifice, radical surgery, involving transplantation of the ureters to either the skin or bowel, with cystectomy, has become increasingly important. Moreover, in certain cases with tumors situated around the trigone and vesical orifice and invading the prostate gland, a radical perineal operation, such as an extension of Young's radical operation for cancer of the prostate gland, can be performed. Before such radical surgery is attempted, it is absolutely necessary to do all in one's power to eliminate the possibility of either local or distant metastases.

Transurethral methods of treatment of bladder tumors have led to a general negligence on the part of urologists in searching carefully for metastases and have given rise to the opinion that metastasis from bladder tumors is rare and usually occurs only late in the course of the disease. Further support for this attitude is gained from the fact that many so-called benign papillomas of the bladder, which are potentially malignant, are not regarded with sufficient suspicion.

It is our purpose to report here 13 cases of papillary carcinoma of the bladder in order to show that clinically detectable metastases from bladder tumors are of rather frequent occurrence. These cases are not the only ones that developed metastases or had metastases at the time that they were under treatment, but these cases are the ones which were proved either clinically or at autopsy.

It is interesting to note that most of these cases were papillary types of bladder tumors, all of which probably were infiltrating, but some of which were small and showed little evidence of infiltration, even at the time of death. Metastasis occurred in some instances when the local tumor was small and apparently amenable to conservative therapy in the way of transurethral methods, or certainly radical surgery, and in some cases the primary tumor was thought to have been controlled or even eradicated. In several instances metastasis occurred relatively early

after the onset of the first symptoms. In one case bilateral transplantation of the ureters and subsequent cystectomy were considered the procedures of choice until an x-ray of the chest showed a small, circumscribed nodule of metastasis in the left lung. The following case reports and illustrations show how widespread some of the metastatic lesions may be and emphasize the importance of a careful search for metastases in order to avoid radical operations which are doomed to failure because of metastases. In such cases transurethral methods, plus high voltage therapy, constitute the procedure of choice.

CASE 1.—B.U.I. No. 19447. C. C., a 76-year-old man, was seen March 19, 1930, complaining of nocturia, burning on urination, and hematuria, all symptoms of a gradual progressive type over a period of five years. Five years before, cystoscopy disclosed a papilloma of the bladder, which was fulgurated at another clinic. During the next three years, several fulgurations were done to control intermittent bleeding. Six weeks before admission the symptoms became much more severe, with marked urgency progressing to almost incontinence. The general physical examination was essentially negative. Cystoscopy revealed multiple papillomas of the bladder, described as being short, sessile, papillary, nonulcerative tumors, and thought to be benign. Fulguration resulted in considerable alleviation of the symptoms. The patient returned nine months later with the same complaints. He had lost much weight and the hemoglobin was only 20 per cent. Cystoscopy showed a large papilomatous tumor, which appeared to be infiltrating, occupying the anterior wall of the bladder. Active bleeding was controlled by fulguration. The patient was given a blood transfusion, but failed quickly and died of cardiac failure ten days later. Autopsy revealed a papillary carcinoma of the bladder with extension to the right ureter and renal pelvis, and metastases were present in the liver which was found to be studded with nodules.

CASE 2.—B.U.I. No. 19888. G. H., a 54-year-old white male, was seen Aug. 12, 1930, complaining of burning and pain on urination, nocturia, and hematuria of five months' duration. Physical examination was essentially negative. Cystoscopy revealed a flat, infiltrating tumor, estimated to be 3.5 by 4 cm., covered with short papillary projections, involving the left side of the trigone, and adjacent left lateral wall of the bladder. Treatment consisted of surface application of radium and deep x-ray therapy. He was discharged one month later, but was readmitted in three months, complaining of pain in the suprapubic and perineal regions radiating down the posterior aspect of the left thigh and leg. On cystoscopy no definite tumor was visible. An x-ray of the pelvis showed a metastatic tumor involving the body of the fourth lumbar vertebra and the top of the sacrum. Deep x-ray was given as a palliative measure, with improvement of the pain, but subsequent x-ray revealed a large metastatic area in the left ischium (Fig. 1) as well. The patient died six months after his first admission. No autopsy was obtained.

In this case the symptoms had been present only five months before the patient came to the hospital. No biopsy was obtained, but the appearance of the tumor was such as to necessitate the diagnosis of papillary carcinoma.

CASE 3.—B.U.I. No. 20157. W. G., a 67-year-old white male, was admitted first on Nov. 12, 1930, complaining of frequency, nocturia, hematuria, and pain in the back for six months. The general physical examination was negative. Cystoscopy showed on the right half of the trigone a solid, sessile, lobulated tumor, 3 to 4 cm.

in diameter, with evidence of infiltration about its base. Suprapubic resection of the intravesical mass was carried out with the high frequency current and radium needles were implanted in its base and about its periphery. Microscopic sections of the tumor revealed an infiltrating papillary carcinoma. He was greatly improved at time of discharge, seven weeks after operation. He was readmitted three months later complaining of a suprapubic urinary fistula, frequency and burning on urination, and hematuria. Plain x-ray of the pelvis showed undoubted metastasis in the right ischium and pubis, which had been clear prior to operation. The patient was improved on discharge. No further records on the case were available.



Fig. 1.—Flat plate of pelvis (Case 2), showing large area of osteolytic metastasis in the left ischium.

CASE 4.—B.U.I. No. 20998. C. C., a 52-year-old white man, admitted Sept. 24, 1931, complained of frequency and urgency of urination and hematuria, which had been present intermittently for two years. General physical examination revealed evidence of marked weight loss; dullness and impaired breath sounds in the left posterior lung field; and a palpable mass, about the size of a lemon, in the left side of the abdomen opposite the umbilicus. Renal function tests were normal. X-ray of the chest showed numerous circumscribed areas scattered throughout both lungs, characteristic of metastases. Gastrointestinal series was negative, except for displacement of the stomach due to what was thought to be an extragastric mass. Cystoscopy showed an infiltrating papillomatous tumor, with a broad base, about the size of a half dollar, located on the anterior wall. Treatment consisted simply of fulguration and the surface application of radium to destroy the local growth and relieve the symptoms. The patient died at home; no autopsy was obtained.

This case is an excellent example of widespread metastases from a small tumor of the bladder which, except for the presence of the metastases, certainly would have been considered amenable to either transurethral methods or suprapubic excision. If the metastatic lesions in the chest and the abdominal mass had been smaller, the metastases might easily have been missed.

CASE 5.—B.U.I. No. 21474. M. F., a 54-year-old man, admitted on April 6, 1932, complained of painless hematuria which had been present intermittently for a period of three years. He had been treated elsewhere, one year before, for a papilloma of the bladder. He was admitted in coma. Because of a distended bladder, he was catheterized and a decompression apparatus set up. General physical examination revealed a moderate cardiac enlargement with systolic murmurs at the apex and base. The blood pressure was 190/90. The blood urea was 56 mg. Cystoscopy could not be carried out, and the patient died a few hours after admission. Autopsy revealed a small papillary carcinoma of the bladder, 1 cm. in diameter, with extension to the region of the seminal vesicles and multiple metastases in the liver. There was a benign prostatic hypertrophy, but no renal disease was present.

This is another example of a very small infiltrating papillary carcinoma of the bladder with extensive metastases.



FIG. 2.—Flat plate of pelvis (Case 6), showing the marked bone destruction due to metastasis from a carcinoma of the bladder.

CASE 6.—B.U.I. No. 21499. M. E., a 46-year-old man, admitted May 2, 1932, complained of a bladder tumor which had been known to be present for one and one-half years and which had been treated by fulguration. The symptoms on admission were frequent and painful urination. The general physical examination, except for a hypertension of 182/110, was essentially negative. The blood urea was 36 mg. Cystoscopy revealed a solid, lobulated tumor springing from the bladder wall in the region of the right ureteral orifice, involving the right half of the trigone and extending up on the right lateral wall to the region of the fundus of the bladder. At suprapubic operation the intravesical tumor mass was fulgurated and coagulated thoroughly and radium needles implanted in its base, a total of 2,900 mg. hr. of radium being given. Microscopic examination of the material removed at operation showed papillary carcinoma. The postoperative course was stormy, but he was discharged in six weeks, greatly improved. During the next

three years he was readmitted several times for the purpose of removing vesical calculi which kept forming on the surface of the radium burn. Three years subsequent to his first admission, the patient noted pain and stiffness in the right hip and thigh. X-ray revealed evidence of osteolytic metastasis to the acetabulum, ischium, and superior ramus of the pubis. Careful study of the bladder showed no evidence of recurrence of the tumor growth. Deep x-ray therapy was given to the region of the right hip with alleviation of the pain. The patient was readmitted one year later because of excruciating pain in the right hip, thigh, and knee. Examination at this time showed marked enlargement and deformity of the right side of the pelvis and upper thigh. X-ray showed the right side of the pelvis to be almost completely destroyed by an osteolytic metastatic lesion (Fig. 2). Cystoscopy revealed an extensive recurrence of the bladder tumor involving the left half of the trigone and the bladder floor. The patient died one month later; no autopsy was obtained.

CASE 7.—B.U.I. No. 22575. R. W., a 62-year-old man, admitted Oct. 10, 1933, complained of frequent urination and intermittent hematuria over a period of two years. The general physical examination was essentially negative except for palpable enlargement of the liver. Rectal examination was negative. On cystoscopy there was seen a large, shaggy, papillary tumor involving the vesical orifice and extending over the left half of the trigone up to the left lateral wall, obscuring the left ureteral orifice. X-ray of the pelvis revealed an osteoplastic metastasis in the right ilium. Cystogram showed an extensive filling defect involving the left lateral wall of the bladder. Biopsy of the growth revealed papillary carcinoma. Fulguration of the growth was carried out on two occasions with considerable relief of symptoms. The patient was readmitted two months later, at which time considerable decrease in the size of the tumor was noted. The patient received a series of radium applications to the base of the tumor. Ten months after the first admission, x-ray revealed changes in the right ilium and pubis which were characteristic of metastasis. Cystoscopy at this time showed a recurrence of the bladder tumor and evidence of infiltration. The patient was not seen thereafter.

CASE 8.—B.U.I. 23362. A. S., a 34-year-old man, admitted to the orthopedic service on Oct. 11, 1934, complained of pain in the left hip of two months' duration, and intermittent hematuria over a period of one year. Examination revealed an emaciated man who looked chronically ill. There was localized tenderness in the region of the left sacroiliac joint, but no mass or swelling could be made out. Cystoscopy revealed a large, papillary, pedunculated tumor springing from the region of the left ureteral orifice. The tumor was nonulcerative and did not appear infiltrative. The renal function tests were normal. Intravenous urography revealed a hydronephrosis on the left side. X-ray of the bones of the spine and pelvis showed changes which were interpreted as being an extensive arthritis of the left sacroiliac joint rather than metastasis. Suprapubic cystostomy was performed and the tumor, which was found to be 7 cm. in diameter, was excised and the base fulgurated. The pathologic report was papillary carcinoma. Convalescence was uneventful, but pain in the left sacroiliac joint continued. X-ray of the pelvis was repeated and showed partial destruction of the left portion of the ilium due to metastasis. This was proved by biopsy of the ilium to be metastatic papillary carcinoma. The patient was readmitted two months later because of increased pain in the left hip. Cystoscopy at this time showed no evidence of recurrence of the bladder tumor, but x-rays of the pelvis showed marked destruction of the left side of the top of the sacrum and ilium (Fig. 3) with some new bone formation. Deep x-ray of this region was given for control of the pain, but the patient died three months later, presumably due to further metastatic lesions, although no autopsy was obtained.

This case was exceedingly interesting in that we were not sure that this was ever an infiltrating tumor of the bladder; it may have been simply a superficial papillary pedunculated tumor. It also illustrates the point that a distant and perhaps widespread metastasis may occur from a relatively small and easily treated tumor of the bladder.



Fig. 3.—Flat plate of pelvis (Case 8), showing the osteolytic metastasis to the left sacroiliac joint from a papillary carcinoma of the bladder.

CASE 9.—B.U.I. No. 24495. C. H., a 63-year-old white male, admitted Jan. 17, 1936, complained of hematuria for six months. The physical examination was negative. Cystoscopy revealed a nodular, infiltrating tumor on the left side of the bladder and around the vesical orifice. Intravenous urogram showed no function on the left side; the right kidney appeared to be normal. The cystogram showed a filling defect involving the left side of the bladder and the vesical orifice. The hematuria ceased after the cystoscopic application of radium, and the patient was discharged. He returned three months later, complaining of marked hematuria, weakness, and jaundice, at which time the liver was thought to be enlarged to five fingerbreadths below the costal margin, and was irregular and firm. A biopsy revealed papillary carcinoma. The blood urea was normal. The van den Bergh reaction showed a prompt biphasic response, 7.3 mg. per cent. The stools were clay colored and fatty. The patient was readmitted one month later in deep jaundice, with marked itching of the skin, weakness, and anorexia. Examination revealed an acutely ill, emaciated man, with the liver palpable at the level of the umbilicus, but with no ascites. Exploratory laparotomy disclosed a large, dark liver and a distended gall bladder and common duct. At the terminal portion of the common duct there was a large, nodular, fixed mass occupying the region of the head of the pancreas. The patient died shortly after operation. Autopsy revealed extensive carcinoma of the bladder

with metastases to the common bile duct, pancreatic ducts, and left adrenal, as well as left hydronephrosis and hydroureter. Microscopic examination of the metastatic sections revealed a papillary carcinoma quite similar to that in the bladder.

Although the local tumor in this case was extensive, nevertheless the case illustrates the necessity for considering metastases as the basis for untoward developments in a case, and this man died not from the local tumor but of metastatic lesions.

CASE 10.—B.U.I. No. 23833. C. S., a 47-year-old man, first seen on April 26, 1935, complained of frequency, nocturia, some dysuria and hematuria, which had been present for a period of eight months and which was gradually increasing in intensity. He also complained of pain radiating down the posterior aspect of the right thigh and leg. Physical examination was essentially negative. On rectal examination there was noted slight induration at the base of the prostate on the right side and also extending up into the posterior wall of the bladder. Intravenous urogram revealed a normal left kidney, but no dye appeared on the right side. Cystogram showed a large, irregular filling defect occupying practically the entire right half of the bladder. On cystoscopic examination the right side of the bladder was found to be occupied by an extensive, irregular, somewhat nodular, infiltrating tumor, which extended from the vesical orifice to the midline anteriorly and down over the right half of the trigone, obscuring the right ureteral orifice. Radium treatment, consisting of 600 mg. hr. of surface radium, was given, together with deep x-ray therapy. There was an immediate response. The pain in the right hip and leg, which had been extremely distressing, disappeared during the first week, and the urinary symptoms gradually disappeared during the course of the treatment. Rectal examination six weeks later showed that the induration at the base of the bladder had almost completely disappeared, and cystoscopic examination showed a remarkable change. The tumor had entirely disappeared except for a small, projecting mass of apparently viable tissue in the region of the right ureteral orifice, which was destroyed by means of the high frequency current. The patient returned three months later with symptoms and signs of increased intracranial pressure, thought to be due to a lesion on the left side of the brain. X-rays of the chest, pelvis, and skull revealed no evidence of metastases. Shortly thereafter a rather sudden exacerbation of all symptoms occurred and the patient became semicomatose. A circumscribed tumor was removed from the region of the third ventricle by Dr. Walter E. Dandy. The surgical pathologic report stated that it was obviously not a primary brain tumor and that it suggested very strongly a carcinoma arising from transitional epithelium. The patient did not survive. Autopsy showed no evidence of tumor anywhere except in the brain and the bladder. The right kidney was atrophic and hydronephrotic. The left kidney and ureter were normal. When the bladder was opened, there was no gross evidence of tumor, but there were two dense scars involving the right side of the trigone and the right lateral wall. Only two small areas of superficial ulceration were seen and it required serial sections through these areas to find any tumor.

This case was interesting: (1) in that it represented an unusual metastasis from any tumor; that is, tumor of the brain without any other evidence of metastasis elsewhere; and (2) because of the almost miraculous response to deep x-ray and radium of the large bladder tumor. Two other cases of the same type have been reported, one by Lower and Watkins and the other by McKay. The mechanism of such a metastatic deposit is a little hard to understand, but it must be that a few tumor cells

get into the blood stream and are carried through the pulmonary circulation to the brain. This case was reported in more detail by Leadbetter and Colston.

CASE 11.—B.U.I. No. 26450. G. H., a 49-year-old man, was admitted Dec. 9, 1937, complaining of a bladder tumor which had been diagnosed elsewhere in July, 1937, and treated by deep x-ray and fulguration without any results. The patient complained of great frequency, hematuria, anorexia, and loss of weight and strength. The general physical examination, except for marked malnutrition, was negative. On rectal examination the prostate was felt to be slightly enlarged, with induration at its base and in the region of the base of the seminal vesicles, which was thought

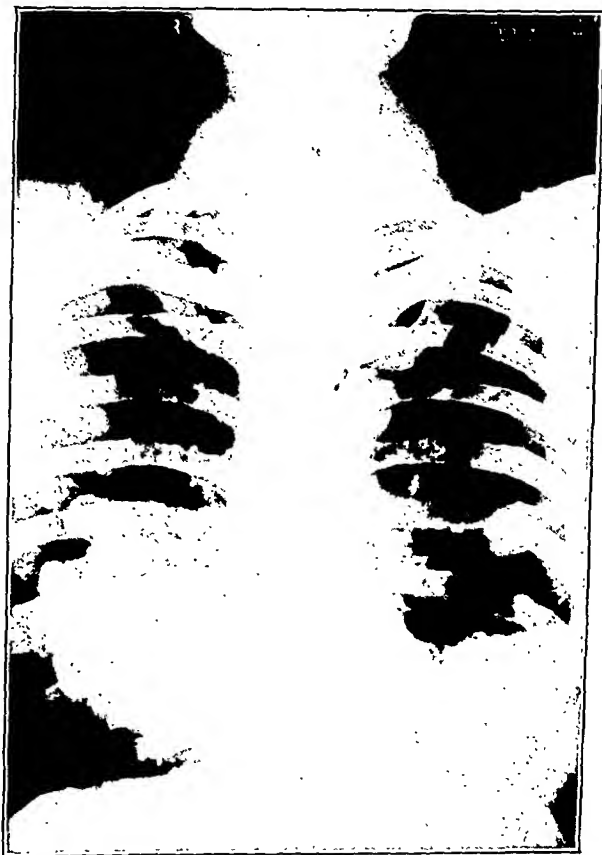


Fig. 4.—X-ray of the chest (Case 12), showing the widespread metastatic lesions in the lungs from the primary carcinoma of the bladder.

to indicate infiltrating tumor extending through the bladder wall. The laboratory studies were within normal limits. Intravenous urogram showed an early hydro-nephrosis on the right side; the left kidney appeared quite normal. Cystogram revealed an extensive filling defect involving the right side of the bladder. Cystoscopy showed a large, ulcerating tumor involving the right lateral wall of the bladder and the right half of the trigone. Transplantation of the ureters into the large bowel, followed by cystectomy, was considered, but x-ray of the chest showed a

clearly defined pulmonary metastasis. No biopsy of the tumor was obtained and the patient was discharged without treatment.

CASE 12.—B.U.I. No. 25360. T. W., a 50-year-old man, was seen in the outpatient department on Dec. 17, 1936, complaining of painless hematuria, usually initial in character, for a period of about one year. The general physical examination was negative. Blood studies and renal function tests were normal. Intravenous urogram showed both kidneys functioning well. Cystogram showed a filling defect on the right side of the bladder. Cystoscopy revealed a tumor in the region of the right ureteral orifice; described as a pedunculated papillary growth, 3 cm. in diameter, with evidence of fusion of the superficial papillae, slightly necrotic, and with a rather broad pedicle. The impression was noninfiltrating papillary carcinoma. Treatment consisted of fulguration and the application of 200 mg. hr. of radium to the surface of the tumor, following which the hematuria ceased and the patient was discharged, to be followed in the outpatient department. He was readmitted one month later, when the remaining tumor was again fulgurated and 200 mg. hr. of radium was applied. The patient was instructed to return in three weeks for further treatment, but he was not seen again until seven months later, at which

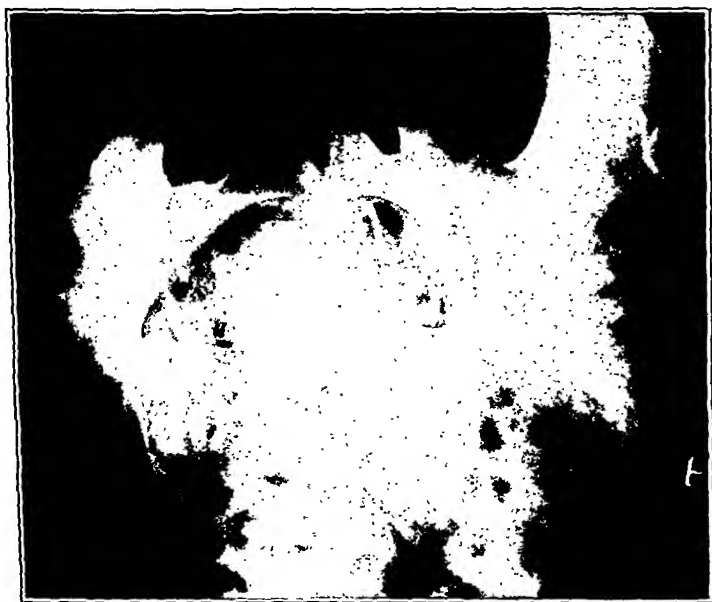


Fig. 5.—Flat plate of the pelvis (Case 12), showing the marked involvement of the bones of the right hip by the metastatic process from the carcinoma of the bladder.

time he stated that he had been passing bloody urine for several months. General physical examination and laboratory studies were negative. Cystoscopy showed, in the region of the right ureteral orifice, a large, sessile, superficially papillary, infiltrating tumor, about 3 cm. in diameter. Treatment again consisted of fulguration and the application of 200 mg. hr. of radium. One month later he had developed considerable pain in the right hip, but an x-ray of this region showed no evidence of metastasis. There was, however, a slight change in the hip joint which was interpreted as being due to arthritis. At this time the bladder tumor showed some evidence of extension and more infiltration, and 200 mg. hr. of radium was applied. Biopsy at this time showed papillary carcinoma. The patient was started on deep

get into the blood stream and are carried through the pulmonary circulation to the brain. This case was reported in more detail by Leadbetter and Colston.

CASE 11.—B.U.I. No. 26450. G. H., a 49-year-old man, was admitted Dec. 9, 1937, complaining of a bladder tumor which had been diagnosed elsewhere in July, 1937, and treated by deep x-ray and fulguration without any results. The patient complained of great frequency, hematuria, anorexia, and loss of weight and strength. The general physical examination, except for marked malnutrition, was negative. On rectal examination the prostate was felt to be slightly enlarged, with induration at its base and in the region of the base of the seminal vesicles, which was thought

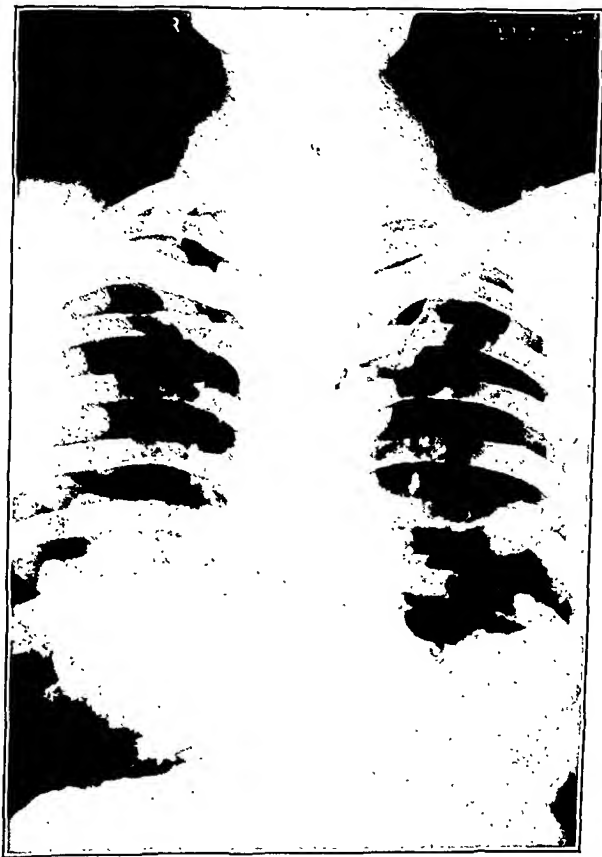


Fig. 4.—X-ray of the chest (Case 12), showing the widespread metastatic lesions in the lungs from the primary carcinoma of the bladder.

to indicate infiltrating tumor extending through the bladder wall. The laboratory studies were within normal limits. Intravenous urogram showed an early hydro-nephrosis on the right side; the left kidney appeared quite normal. Cystogram revealed an extensive filling defect involving the right side of the bladder. Cystoscopy showed a large, ulcerating tumor involving the right lateral wall of the bladder and the right half of the trigone. Transplantation of the ureters into the large bowel, followed by cystectomy, was considered, but x-ray of the chest showed a

two months later, at which time physical examination revealed marked emaciation, impaired percussion note, decreased tactile and vocal fremitus over the right chest below the sixth rib, and considerable atrophy of the muscles of the right thigh with great pain accompanying movement of the leg. X-ray of the chest showed numerous large metastases (Fig. 4) and that of the right hip showed increased destruction of the acetabulum (Fig. 5). The patient's course in the hospital was steadily downhill, but he lived a surprising length of time in view of the extensive metastases, death occurring three months after the last admission. Autopsy showed extensive



Fig. 8.—Section showing the metastatic tumor (Case 12) invading a vertebra and growing in its characteristic papillary formation (low power).

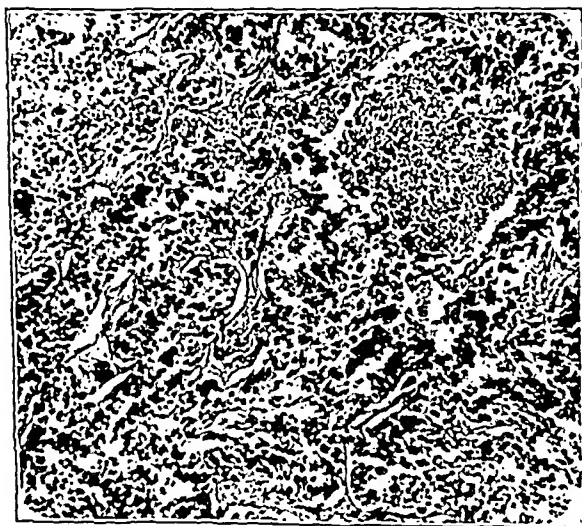


Fig. 9.—Metastatic tumor (Case 12) growing in the liver in characteristic invasive manner (low power).

metastases to the iliac glands, liver, both lungs, the mediastinal glands, the vertebrae, sternum, ribs, and pelvis. There was also a cystitis, a bilateral hydronephrosis, and hydronephrosis on the left side. On microscopic study all of the metastatic

x-ray therapy, which was continued in the outpatient department after his discharge. He was readmitted shortly thereafter complaining bitterly of pain in the right hip which radiated down the thigh toward the knee. Physical examination, aside from some obvious loss of weight, was negative, and there was nothing palpable about the hip or in the thigh which could account for his pain. Cystoscopy was again carried out and 200 mg. hr. of radium applied to the surface of the tumor. X-ray of the right hip showed early destruction about the hip joint characteristic of metastasis. Intravenous urogram showed hydronephrosis of the right kidney. His last admission was



Fig. 6.—Section from the bladder tumor (Case 12), showing a typical papillary carcinoma (low power).



Fig. 7.—Section showing the tumor cells in the lung (Case 12) growing in a very wild and invasive fashion (low power).

cases, before treatment is carried out, careful search by all means at our disposal will be made for a possible silent metastasis.

CONCLUSIONS

All bladder tumors should be regarded with high suspicion, because many apparently benign papillomas of the bladder eventually may recur as malignant, spreading tumors.

All cases should have an intravenous urogram to determine the function and gross condition of the kidneys.

Metastases may occur relatively early in the course of the disease and may be located at a considerable distance from the primary site without any evidence of lymphatic involvement, such as in the case of metastasis to the brain or to bone.

Metastases may occur in spite of the fact that treatment of the local tumor is progressing quite satisfactorily. This should indicate that a more frequent checkup of bladder tumor cases should be made so that we will not be lulled into a sense of false security while a possible metastasis is developing.

If radical surgery is to be considered, thorough x-ray study of the chest, the bones of the pelvis and spine, and the long bones, as indicated, should be obtained.

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lesions showed the same typical configuration of papillary carcinoma as seen in the original tumor (Figs. 6-9).

The widespread metastases from a relatively small, infiltrating, papillary carcinoma of the bladder make this case unusually interesting. It is also interesting to note that the metastases developed to a large extent after the onset of deep x-ray therapy. Whether or not this had anything to do with the incidence of metastasis would be hard to say, but it has been suggested by this and other cases.

CASE 13.—B.U.I. No. 26207. Mrs. C. E. K., a 65-year-old woman, was admitted Sept. 27, 1937, complaining of a bladder tumor which had been diagnosed elsewhere only a few days previously. Her symptoms had been present for several years, manifested by frequency, nocturia, and very slight hematuria. General physical examination was negative. Renal function tests were within normal limits. Cystoscopy showed a well-demarcated, globular, rather solid neoplasm, with superficial papillary processes, occupying the base of the bladder, involving the trigone in the midline, and extending backward and to the right, apparently involving the region of the right ureteral orifice. Biopsy showed a papillary infiltrating carcinoma. The tumor was fulgurated and surface radium applied on several occasions. Intravenous pyelogram showed a nonfunctioning right kidney and slight dilatation of the lower left ureter, but the left kidney appeared normal. Vaginal examination showed evidence of infiltration of the tumor into the vesicovaginal septum. Plain plate of the abdomen showed no evidence of metastasis to the bones of the spine or pelvis. She was symptomatically greatly improved on discharge. The patient was readmitted three months later complaining of chills and fever. The general physical examination revealed nothing of note. On cystoscopic examination the tumor appeared smaller but not greatly altered. In addition, several small, new tumors were noted, which were fulgurated. She was readmitted two months later complaining of pain in the right shoulder and left hip and intermittent attacks of fever and weakness. Physical examination showed no demonstrable changes in the bony framework, but x-rays of the right shoulder showed a rarefaction at the head of the right humerus characteristic of a metastatic lesion, and x-rays of the thoracic and lumbar spine revealed metastases. Cystoscopy showed a solid, globular tumor mass, involving the left half of the trigone and the left bladder base and extending down to the vesical orifice. Vaginal examination showed extensive infiltration into the pelvic tissues on the left side. The metastatic lesions were treated with deep x-ray with considerable relief of the pain. No treatment of the local tumor was carried out. The patient was discharged and the outcome is not known.

SUMMARY

The thirteen cases of bladder tumor with metastases, presented above in brief, were seen during a period of eight years at the Brady Urological Institute. We realize that they do not represent the total number of cases of bladder tumor in which metastases developed during this period, since many of the cases were not studied from this viewpoint and several of the others who died did not have post-mortem examination. It is of interest to note that all of our cases, with possibly one or two exceptions, were papillary carcinomas of the bladder.

We hope that this study will lead to a more general appreciation of the part played by metastases in cases of bladder tumors, and that in all

SCALENUS ANTICUS SYNDROME AND CERVICAL RIBS*

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SCALENUS anticus syndrome¹ is a symptom complex characterized by a brachial neuritis with or without vascular or vasomotor disturbance in the upper extremity. The pathologic condition is due to mechanical irritation or pressure² on the brachial plexus and subclavian artery produced by the anatomic relations of these structures to the scalenus anticus muscle and first thoracic rib (Fig. 1). This pressure was noted by Murphy³ in 1915 while resecting a cervical rib, but he made no attempt to remove the pressure. Ten years later, Adson⁴ performed and recommended scalenotomy instead of rib resection in cases of cervical rib. The good results of the new procedure, as reported by Adson, suggested to Naffziger⁵ that the scalenus anticus muscle might be the cause of the symptoms when a cervical rib is suspected but cannot be demonstrated on roentgenograms. This group of cases with identical symptoms as seen in 5 to 10 per cent of cervical ribs⁶ is recognized today as scalenus anticus or Naffziger syndrome.

The diagnosis of scalenus anticus syndrome is based upon the presence of a brachial neuritis, but there is no definite means of establishing the mechanical origin of the neuritis or the fact that the scalenus muscle is the cause of the compression. To confirm the diagnosis, Ochsner, Gage, and DeBakey⁷ and Spurling and Bradford⁸ have used oscillometric readings. We, however, have found the same characteristic readings in normal individuals. The frequent uncertainty in diagnosis, as well as the many conditions which may compress the brachial plexus, makes it unlikely that scalenotomy, the recognized treatment, will always give complete relief. Permanent changes may occur in the nerves, arteries, and extremity which will limit the relief to be obtained from operation. This is contrary to the unusually successful results reported by the above authors and others⁹ who advise routine scalenotomy. Further, the fact that the symptoms are aggravated by faulty posture indicates that conservative treatment is frequently all that is necessary. In twenty cases of suspected scalenus anticus syndrome which we have examined, scalenotomy was performed on three patients. These three cases, which are reported herewith, were thoroughly examined by neurologists who confirmed the diagnosis and recommended operation.

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in changing from the sitting position to the reclining position. On the left, uninvolved side, the oscillometric index increased from 5.2 to 7.4 in the arm and from 2 to 3.4 at the wrist. In the reclining position the average temperature of the right (involved) fingers was 32.2° C., which was higher by almost 1° C. than on the left side. After sitting in a chair for one-half hour, the originally higher temperature on the right side dropped to 29° C., while on the left the average temperature declined from 31° C. to 30° C. Temporary novocain block of the ulnar nerve eliminated the above change in peripheral temperatures.

On April 20, 1936, resection of the right cervical rib was performed. No improvement in oscillometric readings or symptoms following the operative procedure.

On Oct. 25, 1937, the oscillometric readings, peripheral skin temperatures, and symptoms were unchanged from the initial examination made before rib resection. The same findings were obtained on Dec. 1, 1937. In the absence of symptomatic relief from the rib resection, scalenotomy was then decided upon.

Right scalenotomy was performed on Dec. 16, 1937. The scalenus anticus muscle and the posterior fibrous sheath were markedly hypertrophied. Definite clinical improvement with relief of pain followed this operative procedure. Although the peripheral arterial pulsations did not return, there was a slight increase in the oscillometric index, and almost normal skin temperatures. Because of thrombosis in the subclavian artery, the normal peripheral pulsations were not restored.

Comment.—After more than five years of suffering with a unilateral condition of the right hand which was repeatedly diagnosed as Raynaud's disease, roentgenograms revealed extensive bilateral cervical ribs. Resection of the rib on the involved side gave no symptomatic relief. Oscillometric index did not vary with postural change, but this was due to thrombosis of the subclavian artery. More than eighteen months later, scalenotomy was followed by marked relief of the neurologic symptoms.

CASE 2.—Dr. L. T., aged 47 years, was examined because of weakness and numbness of the right fingers, hand, and forearm and mild atrophy of dorsal interossei muscles. Although similar symptoms were present to a slight extent on the left side, these were not troublesome compared to those on the right. No objective sensory disturbances were present. Moderate tenderness of the right scalenus anticus muscle was elicited by digital pressure, but there was no aggravation of the peripheral symptoms. In changing from the upright to the reclining position, a markedly increased oscillometric index of 3.5 was present on the right arm and only 1.5 on the left (Fig. 4). Cervical roentgenograms were negative. There was no history of trauma. Tenotomy of the right scalenus anticus muscle was performed on June 10, 1938.

Within forty-eight hours after the scalenotomy, there was definite improvement in the ulnar side of the hand, but the remainder of the hand rapidly became worse and was associated with atrophy and deformity of the small muscles of the hand. This became so severe that on Nov. 11, 1938, the right brachial plexus was explored through the original scalenotomy incision. No adhesions or abnormality were found.

Comment.—Although the diagnosis of scalenus anticus syndrome was confirmed by a number of neurologists, only temporary and partial relief followed scalenotomy. Subsequently, exploration of the supraclavicular triangle failed to reveal a cause for continuation and progress of the symptoms. The latest neurologic report indicates the presence of a cord lesion.

trauma. In 1931 he noticed several blue spots on the fingers of his right hand which were associated with moderately severe burning and sharp pains. Within two months the finger tips became ulcerated. The gangrenous finger tips completely healed within one week. This was followed by incomplete fixation of the interphalangeal joints, contraction deformities, and marked atrophy of the fingers. There was some improvement in the pain and coldness of the fingers, but for the past three years the condition has remained unchanged, still painful and markedly sensitive to cold.

Although the above symptoms were entirely unilateral, roentgenograms revealed large bilateral cervical ribs (Fig. 3). In spite of the fact that the left cervical rib was almost as large as the right, the left side was symptomless.

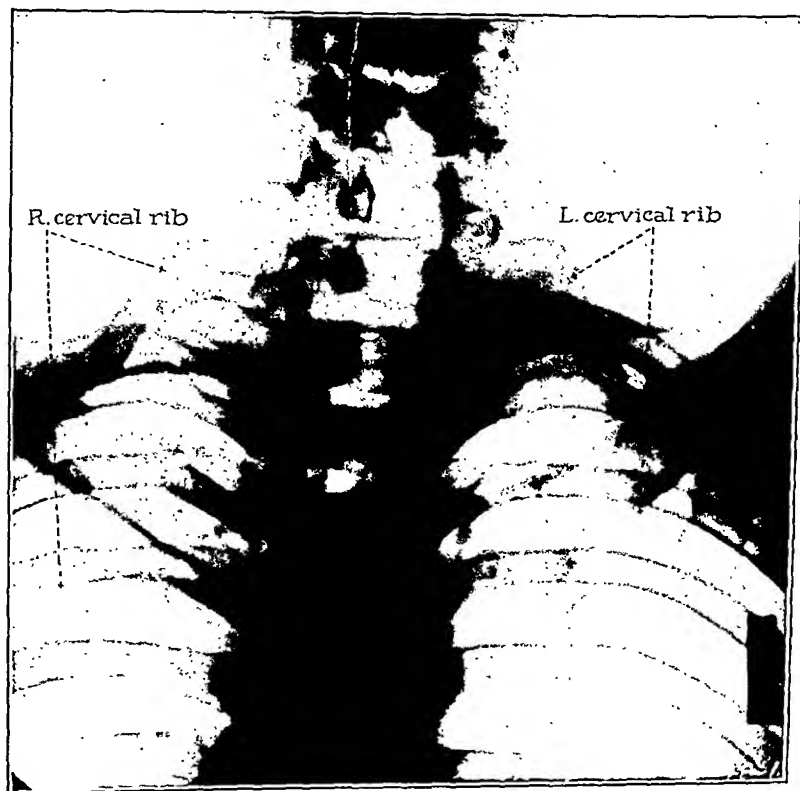
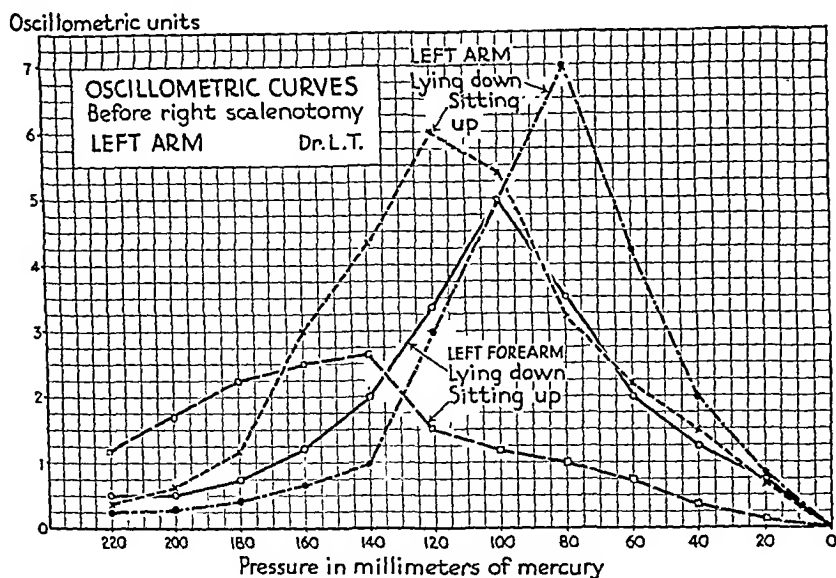


Fig. 3.—Roentgenogram of bilateral cervical ribs of case shown in Fig. 2 (Case 1).

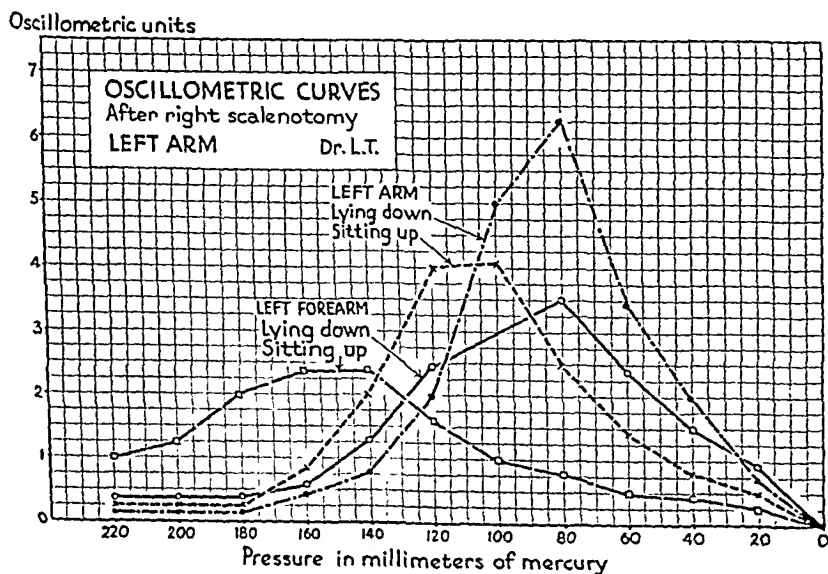
Examination on March 24, 1936, revealed cold, atrophied, and deformed fingers of the right hand. The skin was cyanotic, atrophic, and shiny. The right radial, brachial, and subclavian artery pulsations could not be palpated. Definite tenderness was present in the right supraclavicular triangle. The average temperature of the fingers of the involved right hand was about 2° C. lower than that on the left hand. Complete neurologic examination of the extremity showed no sensory disturbances.

Oscillometric and peripheral temperature readings were made on both the right and left upper extremities in the sitting and reclining positions. The oscillometric readings on the right side were markedly reduced (less than 1) and varied but little

The postoperative improvement in the ulnar nerve symptoms was associated with greatly reduced oscillometric indices compared to those observed before operation (Figs. 4 and 5). With direct pressure on the subclavian artery as the cause of peripheral circulatory changes, the same oscillometric readings should be obtained in the reclining position



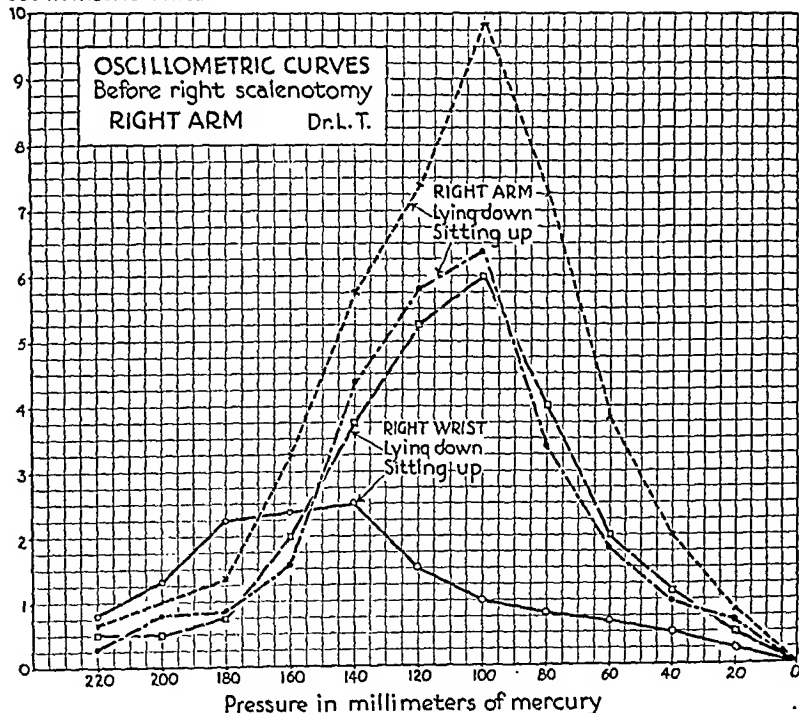
A.



B.

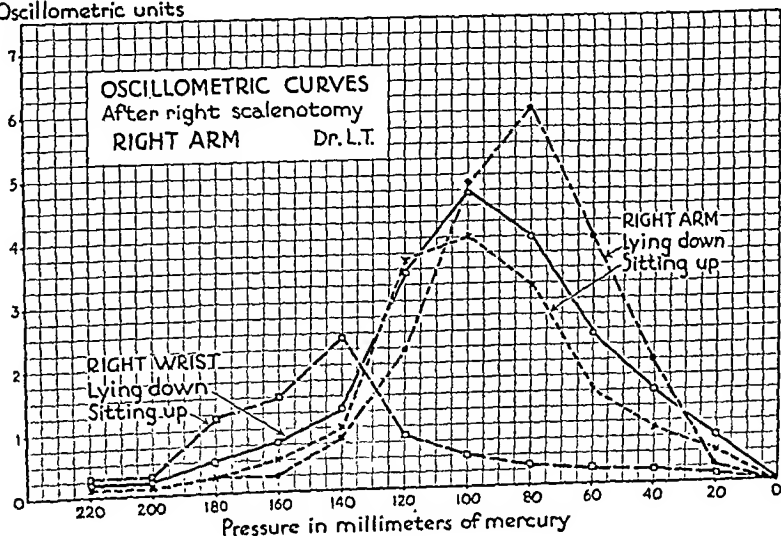
Fig. 5.—Oscillometric curves of the left upper extremity on the same patient as charted in Fig. 4, before (A) and after (B) right scalenotomy. The index on the left extremity was reduced, although the operation was performed on the right side. This indicates that bilateral circulatory changes occur with unilateral operation. The average temperature of the fingers was always higher with the patient in the reclining position than in the sitting position.

Oscillometric units



A.

Oscillometric units



B.

Fig. 4.—Oscillometric curves of the right upper extremity before (A) and after (B) right scalenotomy (Case 2). In changing from the sitting to the reclining position before operation, the oscillometric index of the arm increased from 6.4 units to 9.9 units, while at the wrist the index increased from 2.5 units to 6 units. After operation the index of the arm increased from 6.3 units in the upright position to 6.3 units in the reclining position, while at the wrist the index increased from 2.1 units to 4.7 units. After operation the index in the reclining position was only at the level obtained in the sitting position before operation. If the changes in oscillometric readings were due to direct pressure on the subclavian artery, the same level should be reached in the reclining position both before and after operation. Loss of vascular tone which followed vasomotor irritation by the scalenus anticus muscle could account for these vascular changes.

inner side of the arm, forearm, and the fourth and fifth fingers. Atrophy of the small muscles of the hand or even of the deltoid¹¹ and other muscles of the arm may occur. Circulatory changes, such as cyanosis, pallor, coldness, atrophy, or gangrene of the fingers, are less frequently observed than the neurologic symptoms; but recent reports,¹² as well as our observations, indicate that the disturbance is largely vasomotor in origin as a result of the brachial neuritis. Ochsner's observation of increased oscillographic index by injecting the cervicodorsal sympathetic nerves as well as our observations on certain characteristics of the oscillographic index (comment on Case 2 and Fig. 4) and on the lowered peripheral temperatures which are elevated to normal by novocain block of the peripheral nerves (Case 1) support the opinion that the syndrome is neurogenic. However, the subclavian artery¹³ may be occluded by extravascular pressure or by thrombosis (Case 1).

Other pathologic conditions may be difficult to differentiate from scalenus anticus syndrome. These include inflammatory, traumatic, or toxic neuritis; subacromial or brachial bursitis; Raynaud's disease; ruptured supraspinatous tendon; and various cord, bone, and joint lesions. Further, mechanical irritation and pressure on the brachial nerves and subclavian artery can be produced by large cervical ribs or elongated transverse process of the cervical vertebra; by abnormalities of the first thoracic rib, brachial plexus, or subclavian artery; or by fibrous bands and adhesions in the supraclavicular triangle. It is obvious that even with the greatest care there will be difficulties in accurately diagnosing scalenus anticus syndrome and in establishing the cause of the brachial neuritis as due to compression by the scalenus anticus muscle.

Considerable importance has been given to diagnostic procedures for determining scalenus anticus pressure. The objective findings which are used to confirm the diagnosis are: (1) supraclavicular tenderness, especially to digital pressure on the trunks of the brachial nerves and scalenus anticus muscle; (2) aggravation of the peripheral symptoms by digital pressure on the scalenus muscle; (3) reduction or obliteration of the peripheral pulse with deep inspiration when the shoulder is dropped and the head is turned to the affected side and hyperextended; and (4) increased oscillographic index after novocain injection of the cervicodorsal sympathetic nerves (Ochsner). Since more than 50 per cent of the cases diagnosed as scalenus anticus syndrome give a history of trauma to the neck or shoulder, the tenderness and the aggravation of the peripheral pain by digital pressure could occur with a traumatic or any type of neuritis.

Oscillographic Readings.—To evaluate the importance of changes in the oscillographic index (maximum reading) as above described, a number of normal individuals were examined with a Pachon oscillogram (Table I). Instead of using Ochsner, Gage, and DeBailey's method of novocain block of the cervicodorsal sympathetic nerves, we took readings

both before and after operation. The greater index before operation can be explained by the loss of vascular tone due to the removal of the irritation or pressure on the vasomotor fibers of the brachial plexus when the patient assumes the reclining position. The absence or reduction of the irritation on the brachial plexus after operation is accompanied by less disturbance in vascular tone and consequently by a smaller variation in oscillometric indices in changing postural conditions.

CASE 3.—Mr. D. D., aged 41 years, a clerk, was referred Nov. 13, 1937, because of troublesome tingling and numbness of both hands and both arms but no circulatory symptoms or atrophy. There was some weakness of the hands but no objective sensory disturbances. At the onset of the above complaints, ten years previously, he had been examined and his condition diagnosed as a functional nervous disorder. Although the symptoms were bilateral, they were most prominent on the right side where digital pressure on the scalenus anticus muscle revealed definite tenderness. Similarly the right radial pulsation was reduced on deep inspiration when the shoulder was dropped, the head hyperextended and rotated to the right. This did not occur on the left side. In changing from the sitting to the reclining position, the oscillometric index increased 1.8 units in the right arm and 1.6 units in the right wrist. There was no change on the left side. Roentgenograms revealed large bilateral cervical ribs.

In spite of the indefiniteness of the neurologic symptoms, the physical findings of unilateral supraclavicular tenderness, and unilateral fluctuation in oscillometric readings and peripheral pulse as above described, right scalenotomy seemed to be warranted. The neurologist who had observed this patient for a number of years believed that removal of scalenus anticus pressure might benefit him.

On Nov. 24, 1937, right scalenotomy was performed and the cervical rib explored; no pressure being found, the rib was not disturbed. Both the muscle and posterior fibrous sheath were hypertrophied. Postoperative oscillometric readings showed that the index in the reclining position did not reach the level obtained prior to operation. This was also observed in the previous two cases, but the same unit increase occurred at a lower level in changing from the sitting to the reclining position than was noted before operation. The symptoms were not greatly relieved by the operative procedure.

Comment.—Symptoms suggesting a brachial neuritis with definite evidence of unilateral changes in the peripheral pulse and oscillometric readings seemed to indicate irritation or pressure on the brachial plexus. At operation the scalenus anticus was hypertrophied and was compressing the subclavian artery and brachial plexus. The cervical rib appeared merely incidental. This patient was not greatly benefited by scalenotomy.

DISCUSSION

The diagnosis of scalenus anticus syndrome is made primarily on the presence of clinical symptoms in the upper extremity which are influenced by posture. The symptoms are not clearly defined but pain, tingling, and numbness may occur anywhere from the shoulder to the fingers;¹⁰ the usual distribution is along the course of the lower brachial trunks (ulnar or mixed median-ulnar nerve) with involvement of the

inner side of the arm, forearm, and the fourth and fifth fingers. Atrophy of the small muscles of the hand or even of the deltoid¹¹ and other muscles of the arm may occur. Circulatory changes, such as cyanosis, pallor, coldness, atrophy, or gangrene of the fingers, are less frequently observed than the neurologic symptoms; but recent reports,¹² as well as our observations, indicate that the disturbance is largely vasomotor in origin as a result of the brachial neuritis. Ochsner's observation of increased oscillographic index by injecting the cervicodorsal sympathetic nerves as well as our observations on certain characteristics of the oscillographic index (comment on Case 2 and Fig. 4) and on the lowered peripheral temperatures which are elevated to normal by novocain block of the peripheral nerves (Case 1) support the opinion that the syndrome is neurogenic. However, the subclavian artery¹³ may be occluded by extravascular pressure or by thrombosis (Case 1).

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THEIS: SCALENUS ANTICUS SYNDROME

TABLE II

SUSPECTED SCALENUS ANTICUS SYNDROME. INCREASE IN, OSCILLOMETRIC READINGS OF ARM AND FOREARM AND INCREASE IN AVERAGE PERIPHERAL TEMPERATURES OF FINGERS IN CHANGING FROM THE SITTING TO THE RECLINING POSITION

CARPUS SYNDROME. INCREASE IN, OSCILLOMETRIC READINGS OF ARM AND FOREARM AND INCREASE IN AVERAGE PERIPHERAL TEMPERATURES OF FINGERS IN CHANGING FROM THE SITTING TO THE RECLINING POSITION										CARPUS ANTICUS SYNDROME										
PATIENT	AGE	SEX	OCCUPATION	MAXIMUM CHANGE OSCILLOMETRIC UNITS						AVERAGE INCREASE IN TEMPERATURE				EXTREMITY INVOLVED						
				ARM		FOREARM		L.	R.	FINGERS		L.	R.							
				R.	L.	R.	L.			R.	L.									
1. J. S.	36	M	Factory worker	0.4	0.4	0.2	0.2	0.2	0.2	+3.0° C.	+2.0° C.	Right		Right						
2. L. T.	47	M	Physician	3.5	1.5	3.6	3.6	2.2	2.2	+1.4° C.	+1.0° C.	Right		Right						
3. D. D.	42	M	Clerk	1.8	0.0	1.6	1.6	0.4	0.4	+0.2° C.	+0.0° C.	Right		Right						
4. F. R.	34	M	Telegrapher	0.5	0.4	1.0	1.0	1.0	1.0	+1.4° C.	+0.6° C.	Right		Right						
5. F. B.	33	M	Pianist	3.4	1.0	1.2	1.2	1.5	1.5	+0.4° C.	+0.7° C.	Right		Right						
6. L. R.	55	M	Contractor	1.8	2.0	1.2	1.2	0.6	0.6	+0.5° C.	+0.5° C.	Bilateral		Bilateral						
7. S. J.	59	F	Housewife	2.5	3.4	1.5	1.5	1.8	1.8	+3.0° C.	+4.0° C.	Right		Right						
8. R. P.	49	F	Housewife	0.5	2.5	1.6	1.6	0.2	0.2	-----	-----	Bilateral		Bilateral						
9. E. D.	52	F	Housewife	2.0	1.8	0.4	0.4	1.5	1.5	-----	-----	Bilateral		Bilateral						
10. V. C.	31	F	Housewife	0.5	3.4	1.3	1.3	0.2	0.2	-----	-----	Bilateral		Bilateral						
11. B. S.	38	F	Housewife	2.0	2.5	1.0	1.0	0.0	0.0	-----	-----	Bilateral		Bilateral						
12. B. C.	51	F	Housewife	1.6	1.8	0.4	0.4	1.0	1.0	+1.5° C.	+1.0° C.	Right		Right						
13. C. E.	47	M	Lawyer	2.4	1.3	1.0	1.0	0.8	0.8	+0.8° C.	+0.0° C.	Left		Left						
14. C. F.	40	M	Contractor	3.5	1.3	0.4	0.4	1.4	1.4	-----	-----	Left		Left						
15. J. H.	37	M	Publisher	0.0	3.0	1.0	1.0	0.0	0.0	-----	-----	Left		Left						
16. M. D.	50	M	Physician	1.0	0.0	1.2	1.2	1.0	1.0	+1.5° C.	+1.0° C.	Right		Right						
17. A. P.	43	M	Housewife	2.4	1.6	1.0	1.0	0.8	0.8	+0.8° C.	+1.0° C.	Right		Right						
18. T. W.	42	M	Tailor	2.5	0.5	1.0	1.0	0.6	0.6	+1.0° C.	+1.2° C.	Right		Right						
19. W. S.	48	M	Factory worker	0.0	2.0	0.8	0.8	2.6	2.6	+0.7° C.	+0.6° C.	Left		Left						
20. J. S.	39	M	Machinist	0.3	1.5	0.6	0.6	1.5	1.5	+1.1° C.	+1.4° C.	Left		Left						
			Mechanic	2.0	2.0	1.9	1.9	1.3	1.3	+1.5° C.	+1.7° C.	Left		Left						

TABLE I

NORMAL CONTROLS. INCREASE IN OSCILLOMETRIC READINGS OF ARM AND FOREARM IN CHANGING FROM THE SITTING TO THE RECLINING POSITION

PATIENT	AGE	SEX	OCCUPATION	MAXIMUM CHANGE OSCILLOMETRIC UNITS				SYMPTOMS
				ARM		FOREARM		
				R.	L.	R.	L.	
1. H. H.	30	F	Nurse	0.0	0.0	0.5	0.4	None
2. H. R.	31	M	Trimmer	2.4	2.8	0.7	1.2	None
3. A. P.	25	F	Secretary	0.0	0.4	0.6	0.4	None
4. F. B.	25	M	Student	2.4	1.8	0.8	0.8	None
5. J. R.	29	M	Student	0.0	0.4	1.3	1.2	None
6. H. W.	55	M	Executive	3.0	2.6	1.6	1.6	None
7. L. D.	32	F	Nurse	1.0	1.0	0.5	1.0	None
8. R. S.	44	M	Machinist	0.5	0.2	0.2	0.0	None
9. R. K.	29	M	Physician	2.0	2.0	0.7	1.0	None
10. N. B.	26	M	Student	0.5	1.5	0.7	1.2	None
11. A. N.	28	M	Technician	2.7	1.0	0.4	0.7	None
12. M. B.	25	F	Secretary	1.0	1.0	1.0	1.2	None
13. R. H.	25	M	Student	2.2	2.1	0.7	0.9	None
14. S. M.	57	M	Unemployed	0.0	0.6	0.2	0.0	None
15. R. A.	20	M	Student	1.0	0.9	0.5	0.7	None

with each change in posture and obtained a similar increase in oscillographic index. The majority of the normal controls had the same findings which have been used for confirming the diagnosis of scalenus anticus syndrome (Table II). The percentage of extremities with increased oscillographic index in the normal controls and of the involved and uninvolved extremities in suspected cases of scalenus anticus syndrome is contained in Table III. All of the involved extremities had some increase in the oscillographic index, while 25 per cent of the uninvolved extremities had no change. The larger increases also occurred more frequently in the involved than in the uninvolved extremity. Still, when compared to the group of normal controls, changes in oscillographic index must be cautiously accepted as a pathologic finding for confirming the diagnosis of scalenus anticus syndrome.

Peripheral Arterial Pulsations.—Reduction or obliteration of the radial pulse on deep inspiration when the shoulder is dropped and the head is turned to the affected side and hyperextended has been reported as significant of scalenus anticus syndrome. We found that a reduction or obliteration of the peripheral pulse occurs in most normal individuals. This was also noted by Spurling and Bradford.⁵ These findings demonstrate that posture affects the peripheral pulse in almost all individuals, but the ease with which the pulse is reduced or obliterated may be the important consideration in the diagnosis of scalenus anticus syndrome.

Treatment.—The fact that posture, stature, and muscular fatigue affect the severity of symptoms and the peripheral circulation (Fig. 6) indicates that conservative treatment is of definite value in alleviating the distress. Although Blair, Davies, and McKissock¹² studied histo-

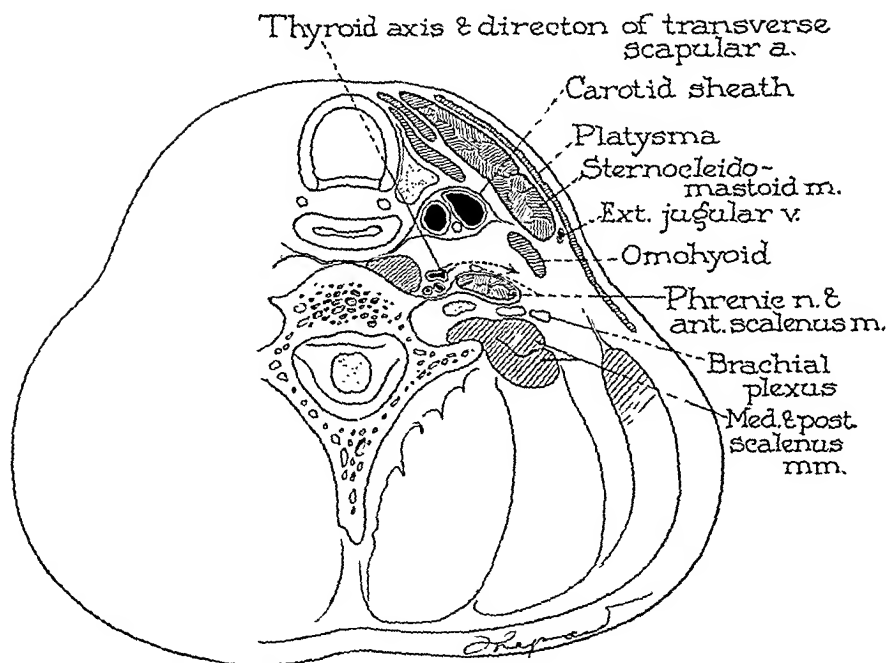


Fig. 7.—Transverse section of cervical region at level at which the scalenus anticus muscle is incised. The thick posterior fibrous sheath of the muscle should be divided with the muscle fibers. This portion of the muscle is directly over the cords of the brachial plexus and care should be taken that all the fibers are cut across.

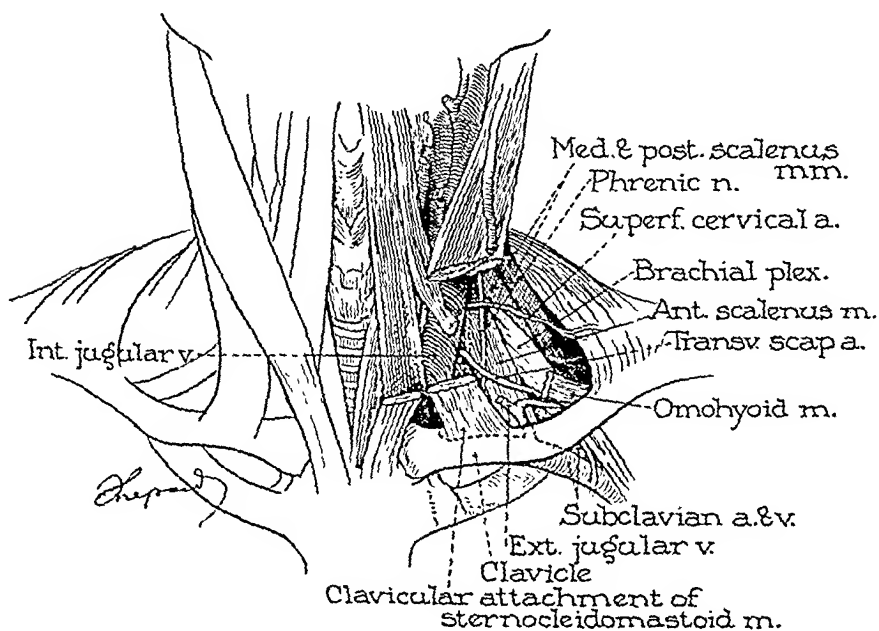
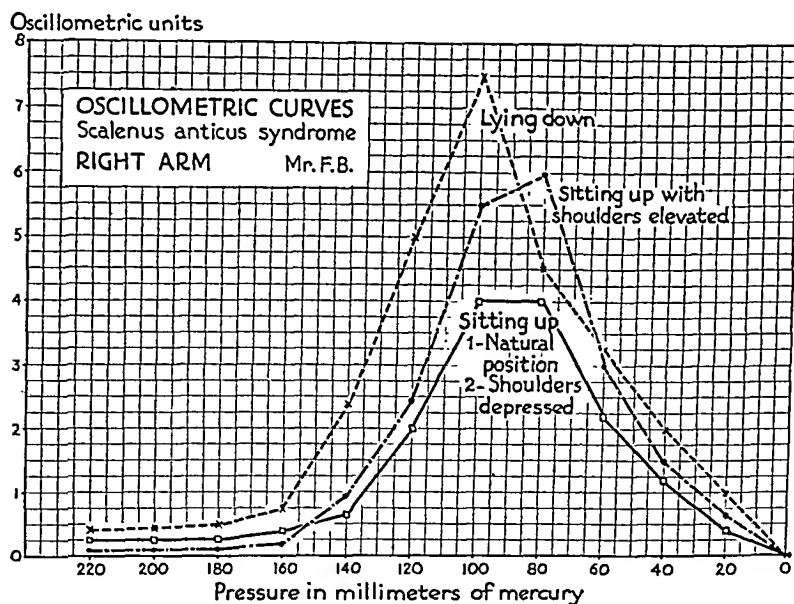
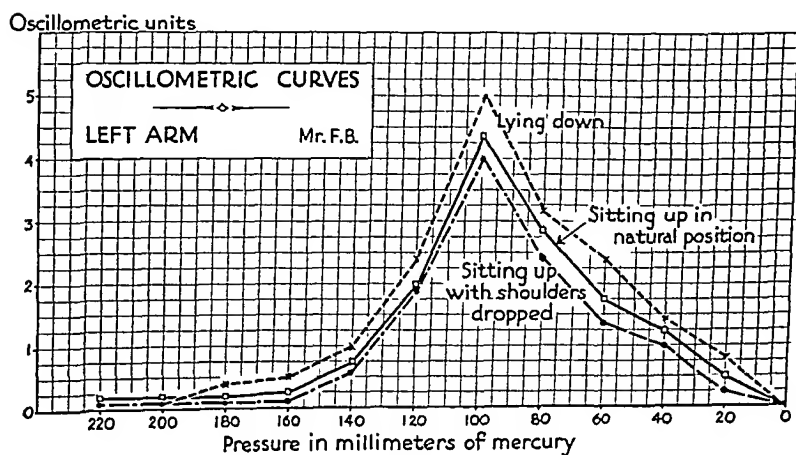


Fig. 8.—Showing the relationship of the scalenus anticus muscle to the brachial plexus and structures of the neck.

logically the brachial plexus in a case of cervical rib and found marked permanent changes in the nerves, routine operation is neither necessary nor is it always successful. Correction of posture, avoidance of fatigue, and in some instances immobilization of the arm and shoulder should be given a fair trial. When relief is not thus obtained, operative interference should be considered.



A.



B.

Fig. 6.—Oscillometric curves showing the effect of postural changes on the right and left extremities of a patient with right side scalenus anticus syndrome (A) (Case 3). On the left side (B) there is little change in the curve in assuming the different positions, while on the right side the index increased from 4 units in the sitting position with the shoulders either depressed or in the natural position of the patient to 6 units with the shoulders elevated and to 7.6 units when lying down. Conservative treatment definitely benefited the patient.

5. Naffziger, H. C.: Quoted by Ochsner.⁷
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TABLE III

PERCENTAGE OF EXTREMITIES WITH INCREASED OSCILLOMETRIC READINGS IN CHANGING FROM THE SITTING TO THE RECLINING POSITION

	NUMBER OF EXTREMITIES	PERCENTAGE OF EXTREMITIES WITH INCREASED OSCILLOMETRIC INDEX				
		NO CHANGE	UNDER 1.0	OVER		
				1.0	2.0	3.0
Normal controls	30	16.6%	23.33%	60.0%	33.33%	3.33%
Suspected scalenus anticus syndrome	..					
Involved extremity	24	None	12.5 %	87.5%	54.16%	12.5 %
Uninvolved extremity	16	25.0%	25.0 %	50.0%	18.75%	6.25%

The operation of scalenotomy is not a difficult procedure. The scalenus anticus muscle (Fig. 7) is deeply placed and is in contact with the brachial plexus and the carotid sheath (Fig. 8). The thick fibrous posterior sheath of the muscle should be incised to permit maximum dropping of the first thoracic rib. Craig and Knepper⁹ believe that elevation of the shoulder girdle due to spasm of the scalenus anticus muscle may produce the same symptoms as a cervical rib. Division of the hypertrophied muscle fibers alone will eliminate the pressure produced by spasm of the scalenus muscle. Unless the posterior sheath of the muscle is divided, the first rib may continue to be elevated and to produce pressure on the nerve trunks and artery.

CONCLUSIONS

Scalenus anticus syndrome is a symptom complex which is due to compression of the brachial plexus. All suspected cases must be carefully scrutinized for the presence of other neurologic conditions.

The diagnostic procedures which demonstrate changes in the peripheral pulse volume and oscillographic index due to posture are not pathognomonic of the disease. The same findings may occur in normal individuals as well as in suspected cases of scalenus anticus syndrome.

Scalenotomy is not indicated in every case of scalenus anticus syndrome. Conservative treatment will benefit most cases with complete relief of symptoms. The best operative result is obtained when a cervical rib is present.

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A SIMPLE TECHNIQUE FOR CHOLECYSTGASTROSTOMY

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THE rationale for short-circuiting procedures on the biliary tract, such as cholecystgastrostomy or cholecystduodenostomy, is an irremovable obstruction to the common bile duct. Such an obstruction is due most commonly to carcinoma of the head of the pancreas or the ampulla of Vater and occasionally to fibrotic stenoses. Whereas cholecystduodenostomy may appear the operation of choice because bile empties normally into the duodenum, it usually cannot be performed as readily as cholecystgastrostomy because of the frequent inaccessibility of the duodenum. Moreover, cholecystgastrostomy apparently functions satisfactorily.

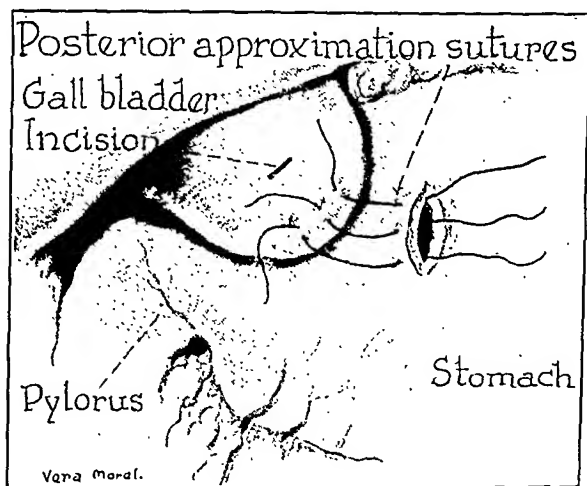


Fig. 1.—Drawing showing posterior row of approximation sutures between lateral edge of incision in stomach wall and fundus of gall bladder.

The technique usually described for the performance of cholecystgastrostomy consists of a suture anastomosis similar to the classical gastrointestinal anastomosis. In 1930 the late J. Tate Mason¹ described a much simpler procedure which has the added advantage of a certain amount of muscular control at the site of the stoma. The procedure consists briefly of introducing a curved hemostat into the lumen of the stomach through a small incision in its anterior wall near the pylorus and gently pushing the blades through the stomach wall

a few centimeters above and distal to the initial incision. The fundus of the gall bladder is then caught with the hemostat and pulled into the lumen of the stomach through the second gastric opening and fixed in this position with a single row of silk sutures. An opening is made in the fundus of the gall bladder by means of a pair of scissors introduced through the initial incision which is subsequently closed.

We have performed the procedure as originally described and found

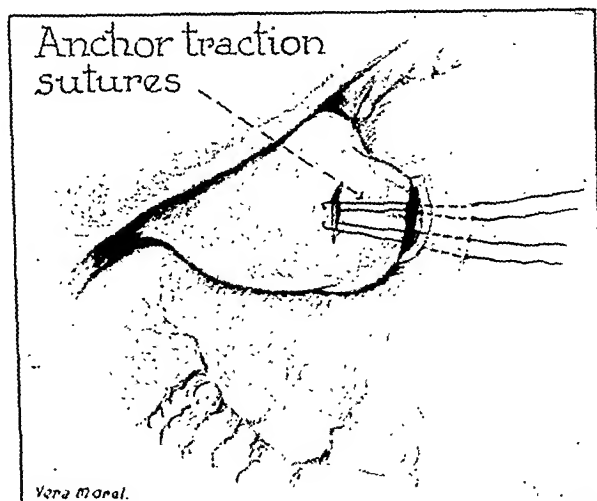


Fig. 2.—Posterior row of approximation sutures have been tied and severed. Anchor traction sutures are simply mattress sutures of silk with the original point of entry and the final point of exit opposite each other in the anterior stomach wall about 1 cm. from the gastric incision, through which they pass to be applied in the upper edge of the incision in the fundus of the gall bladder.

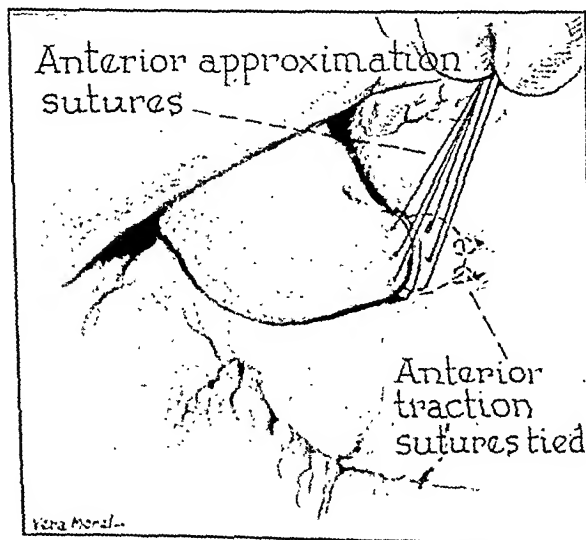


Fig. 3.—Anchor traction sutures have been tightened and tied, drawing that portion of gall-bladder fundus in which opening is made through incision into lumen of stomach as represented by the dotted line. The anterior row of approximation sutures is placed between edge of gastric incision and adjoining wall of gall-bladder fundus.

it to function quite satisfactorily. More recently, however, a slight modification has been employed which is believed further to simplify and facilitate its performance.

The technique consists of making a small incision, 1 to 1.5 cm. in length, in the anterior stomach wall near the pylorus and the lesser curvature. Because the gall bladder is usually distended in these cases, the preliminary aspiration of its contents will greatly facilitate its manipulation. A posterior row of approximation sutures are then placed between the fundus of the gall bladder and the lateral edge of the incision in the stomach (Fig. 1). Three or four interrupted fine silk sutures usually suffice. A small incision, about 6 to 7 mm. in

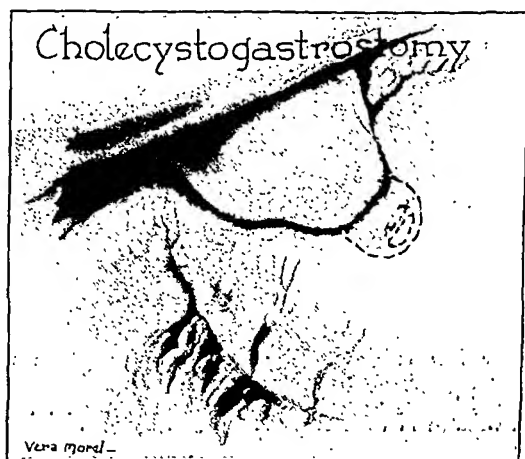


Fig. 4.—Anterior row of approximation sutures has been tied and severed completing the cholecystogastrostomy procedure. A small omental graft may be placed over suture line for reinforcement.

length, is made in the fundus of the gall bladder about 1 cm. from and parallel to the posterior approximation suture line (Fig. 1). Anchor traction sutures are then inserted as illustrated in Fig. 2. Traction upon these sutures draws that portion of the fundus of the gall bladder in which the opening is made through the incision into the lumen of the stomach (Fig. 3). The tying of these sutures helps to secure this position. An anterior row of approximation sutures is then placed between the edge of the gastric incision and the adjoining wall of the gall-bladder fundus (Fig. 3). These three or four interrupted silk sutures are tied, completing the operation (Fig. 4).

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Editorial

Thrombophlebitis

THROMBOPHLEBITIS and its sequelae are of great importance to the clinician because of the occasional tragic outcome and because of the prolonged convalescence following a thrombophlebitic process. In considering intravascular clotting, it is important to distinguish between those lesions which are associated with an inflammatory process in the vessel wall, a true thrombophlebitis, and those in which there is intravascular clotting without the associated inflammatory lesion which can be termed a "phlebothrombosis." It is the latter type which is particularly dangerous, because patients having this condition have relatively few symptoms referable to their vascular systems and because of the absence of inflammatory reaction which tends to fix the thrombus to the vessel wall the likelihood of detachment of the clot and the production of a fatal pulmonary embolism are particularly great.

There are many factors which predispose to the development of thrombi. Trauma of any kind, whether it is operative or is the result of destruction of tissue from infection, predisposes to thrombosis by altering the constituents of the blood. These alterations which favor intravascular clotting are increase in number of thrombocytes and increased agglutinability of the corpuscular elements of the blood. Operative procedures also predispose to thrombosis because of circulatory retardation, the result of relative immobility, postoperatively particularly in the lower extremity. Similarly, circulatory retardation is favored by vasospasm of the peripheral vessels which usually occurs postoperatively. The diminished respiratory activity following an abdominal operation also favors circulatory retardation because of (1) the decreased intrathoracic negative pressure which normally aids in the return of the blood to the thorax, and because of (2) increased abdominal tension resulting from the use of tight abdominal bandages or gastrointestinal distention which compresses the intra-abdominal veins and favors stasis in the lower extremity. Pelvic operations both in the male and female are more likely to be associated with postoperative thromboses than operations elsewhere.

Most patients with thrombophlebitis or phlebothrombosis have some symptoms referable to the involved veins. As emphasized by Homans, the sites involved are most likely to be those areas usually below the entrance of many tributaries. In the lower extremity these are usually in the femoral iliac region and in the calf of the leg just below the popliteal area. The occurrence of pain in the leg associated with fever

it to function quite satisfactorily. More recently, however, a slight modification has been employed which is believed further to simplify and facilitate its performance.

The technique consists of making a small incision, 1 to 1.5 cm. in length, in the anterior stomach wall near the pylorus and the lesser curvature. Because the gall bladder is usually distended in these cases, the preliminary aspiration of its contents will greatly facilitate its manipulation. A posterior row of approximation sutures are then placed between the fundus of the gall bladder and the lateral edge of the incision in the stomach (Fig. 1). Three or four interrupted fine silk sutures usually suffice. A small incision, about 6 to 7 mm. in

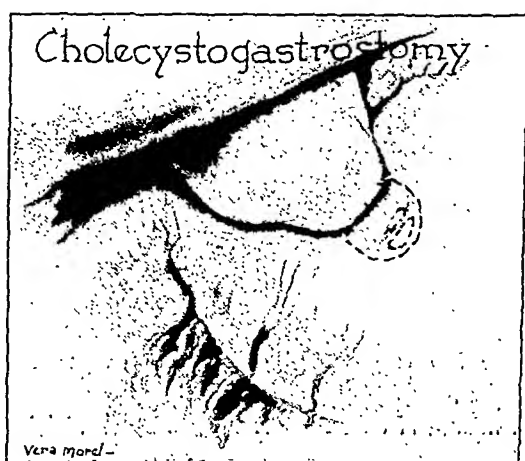


Fig. 4.—Anterior row of approximation sutures has been tied and severed completing the cholecystogastrostomy procedure. A small omental graft may be placed over suture line for reinforcement.

length, is made in the fundus of the gall bladder about 1 cm. from and parallel to the posterior approximation suture line (Fig. 1). Anchor traction sutures are then inserted as illustrated in Fig. 2. Traction upon these sutures draws that portion of the fundus of the gall bladder in which the opening is made through the incision into the lumen of the stomach (Fig. 3). The tying of these sutures helps to secure this position. An anterior row of approximation sutures is then placed between the edge of the gastric incision and the adjoining wall of the gall-bladder fundus (Fig. 3). These three or four interrupted silk sutures are tied, completing the operation (Fig. 4).

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resultant relative tissue anoxia and the diminution in arterial pulsation are the principal factors in the production of edema in thrombophlebitis. We have demonstrated that in thrombophlebitis there is marked diminution in the peripheral arteriolar pulsation in the involved extremity resulting probably from vasospastic influences originating in the thrombophlebitic process. As a result of the decreased blood supply and relative ischemia (anoxia) of the capillary endothelium occasioned by the diminished blood supply, there is an increased permeability of capillary endothelium resulting in an increased exudation of plasma into the perivascular spaces. The persistence of the edema is facilitated by the fact that, if the fluid once gets into the perivascular spaces, it remains there because of the absence of pulsation. Investigations by McMasters have showed that the movement of the lymph is, to a great extent, if not wholly, dependent upon the arteriolar pulsations. In the absence of such pulsations it is probable that the perivascular fluid remains and is not carried away, which accounts for the persistence of the edema. Unless the fluid is removed within a relatively short period of time, that is, within two to three weeks, there is the likelihood of the edema persisting because of fibrosis, which, as is well known, is favored by lymph stasis. It is probably for this reason that the patients who have a phlegmasia alba dolens develop a persistent edema which lasts the rest of their life.

By overcoming the vasospasm in patients with thrombophlebitis by repeated injections of the lumbar sympathetic ganglion with novocain, it is possible to bring about a restitution of normal vascularity within a very short period of time. There is a complete relief of pain within one-half hour after injection; the temperature rapidly falls to normal; and there is a complete subsidence of the swelling of the extremity within two weeks' time. By preventing the persistence of edema, subsequent fibrosis with persistence of symptoms is obviated.

—*Alton Ochsner.*

and tenderness limited to and over the course of a vein is of diagnostic importance. The pain is characteristically increased by having the extremity in a dependent position and is relieved somewhat with the extremity elevated. In most instances there is edema. In thrombophlebitis of the deep veins there is almost invariably a decrease in the peripheral blood supply. Because of this, the name phlegmasia alba dolens has been given to the condition. It is because of the diminished peripheral blood supply and its decreased radiation of heat that the name alba, or white, has been used. However, until relatively recently, little significance has been attached to diminished peripheral blood supply.

It is a well-known fact that in most cases of phlegmasia alba dolens, which are usually the result of femoral-iliac thrombophlebitis and which are frequently associated with postpuerperal or postoperative infections, the prognosis is not good. These patients have fever, marked swelling of the involved extremity due to the edema, and tenderness over the course of the deep vein. These symptoms usually persist for from four to six weeks. Generally, the patients are kept quietly in bed for this period of time and for an additional two to three weeks after the subsidence of the fever, following which they are allowed up. As a rule, after the patient is up there is a return of the edema which is likely to persist for months, even years, and not infrequently for the rest of the life of the individual. Relatively little has been accomplished in the treatment of such cases.

With the introduction of a purified heparin by Best and his associates, much can be accomplished in the prevention of postoperative thrombosis in patients who are potential clotters. The detection of such individuals by the Bancroft formula and the intravenous infusions of heparin over a period of time postoperatively may accomplish a great deal. However, because heparin has relatively little effect upon the condition after a coagulum has occurred, it has limited use in cases of thrombophlebitis or phlebothrombosis in which thrombosis already has occurred.

Leriche first called attention to the beneficial effects of novocain block of the sympathetic ganglia in cases of thrombophlebitis. Based upon our own experience, we are convinced that this is the most efficacious method of treating thrombophlebitis because it results in the re-establishment of normal vascularity within a very short period of time. As a result of recent clinical and experimental observations, we are convinced that an entirely different conception of the development of edema associated with thrombophlebitis is necessary. Contrary to the generally accepted theory that edema of thrombophlebitis is due to an increased venous pressure resulting from blockage of the deep veins, by the occluding thrombi, we believe that, whereas, this may play some role, vasospasm is a far more important factor. According to Leriche, the edema is the result of venous stasis caused by reflex vasospasm. We are of the opinion, however, that the decrease of the arterial supply with its

of metaphen,²⁸ witch hazel,²⁸ aqueous solution of ichthyol 25 per cent,⁷ pure ichthyol,¹⁹³ protargol, 1 per cent,⁷ and pyridium, 0.5 per cent.⁷ Drueck⁴⁶ flushes each diseased crypt thoroughly with water by means of a syringe with an angulated nozzle and generously applies 2 per cent mercurochrome or pure ichthyol for more active stimulation. When such daily treatment is impractical, I have found efficacious the self-application of 15 per cent ichthyol in lanolin by means of a collapsible tube with perforated tip attachment after bowel movements and shortly before retiring.

Operative procedures should be reserved for deep, obviously infected crypts which fail to respond to nonsurgical measures. Simple local excision of the crypt under local infiltration anesthesia has been employed,^{7, 193} but the importance of exterior drainage of the wound well outside the anus has been emphasized by Hirschman⁹⁵ and others^{28, 56} to insure uncomplicated healing. Diathermy has been recommended for cryptectomy by some.^{24, 64, 143} Surgery in the presence of a gonorrheal cryptitis is inadvisable.²⁸

Considerable importance has been placed upon the role of cryptitis as a focus of infection in various systemic affections by a few.^{94, 96, 134, 143} I have seen several patients with persistent *B. coli* infection of the urinary tract which was unrelieved until a gross infection of an anterior anal crypt with a small associated abscess was eradicated. That such infection may be a possible seat for so-called focal infection cannot be denied. But its overemphasis as the explanation of a great variety of constitutional and neurotic disorders is greatly to be deplored.

The importance of the anal ducts, tubular glands emptying into the depths of the anal crypts, in infections in the region of the crypts is emphasized by Tucker and Hellwig,¹⁸² who have made a careful study of their histology and embryonic development. Earlier mention of the possible relationship of these vestigial glands to the development of fistula-in-ano was made by Herrmann and Desfosses⁸⁶ in 1880 and later by Harris⁷⁹ and Lockhart-Mummery.¹⁰⁸

Hypertrophy of Anal Papillae, Papillitis.—Edema, inflammation, and hypertrophy of the anal papillae are secondary to anal cryptitis. The recognition of this fact is important in diagnosis and treatment. Frequently a progressive fibroblastic hypertrophy of a papilla may be incited by chronic crypt inflammation and may continue even after the active crypt infection has subsided. Such a condition may become the source of a definite annoyance to the patient and may require surgical excision. Simultaneous excision of the adjacent crypt is important in the prevention of a recurrence of the condition. In the excision of such an hypertrophied papilla Buie²⁸ recommends approximation of the skin edges at the upper end of the incision by a single suture. This would appear inadvisable when simultaneous excision of a crypt is performed.

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

RECENT ADVANCES IN THE MORE COMMON PROBLEMS OF MINOR ANORECTAL SURGERY

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(Continued from the June issue)

CRYPTITIS

A conspicuous advance in the treatment of anorectal disease has been increasing recognition of the important role played by infection of the crypts of Morgagni in the development of fissure-in-ano, perianal and perirectal abscesses, and fistula-in-ano. This will be discussed further under these headings. Recognition of crypt infection is dependent upon careful anoscopic examination. Proper evaluation of its significance depends upon the experience and judgment of the examiner. Deformity of the crypt margins, enlargement and irregularities of the anal papillae as the end result of an infection long since played out may be of no consequence. The finding of an abnormally deep crypt by exploration with a hooked probe does not by itself warrant the diagnosis of cryptitis. Active infection is revealed by the presence of true signs of inflammation: redness and possibly edema of the margins of the crypt, redness and ulceration of the mucous membrane immediately above the mouth of the crypt, extreme sensitivity to gently probing, and frequently edematous enlargement of the adjacent papillae. It is sometimes possible by pressure over a crypt to express a drop or two of actual pus.

Recognition and treatment of cryptitis in its early localized stage are of great importance in the prevention of numerous complications, notably fissure, abscess, fistula, and anal stenosis. Buie²⁸ regards crypt infection as an important etiologic factor in the development of hemorrhoids.

The usual treatment consists in the application of local heat (hot Sitz baths), lubrication of the stool, and direct application of some medicant. It has been emphasized that the value of the latter depends upon its application with the lower rectum empty of bowel discharges. This can be assured by office procedure or by the employment by the patient of local irrigation with a small warm enema of plain water or saline solution. Some of the drugs utilized include aqueous solution

upon the role of such infection is conspicuously lacking in the literature. Again, many of the nonsurgical methods of treatment may effect a cure in a certain percentage of even this type of chronic anal fissure. Healing is not permanent, however, unless, happily, the responsible infection of the superimposed anal crypt or duct has spontaneously subsided. This does not mean that there is no proper place for these methods of treatment. But it is a plea for their intelligent and rational use in a condition which is a cause of great suffering and from which the patient so ardently desires early, lasting, and permanent relief. The presence of certain features that can be determined by proper examination are definite indications for what might be considered by some radical surgical interference. These features include the presence of a burrowing pocket of infection distal to the fissure, with or without a so-called sentinel pile; the existence of an obviously chronically infected superimposed crypt; and the presence of a definite bar of subcutaneous fibrosis at the upper end of the anal canal, in itself evidence of a chronic inflammatory process secondary to infection by way of an anal crypt. Ideal operative treatment in the presence of any of these above named conditions requires hospitalization for from two to four days. If proper radical operation can be done and control of postoperative discomfort can be obtained by the use of suitable anesthetic agents of prolonged action as an office procedure, this method of treatment is justifiable and commendable. There is usually, however, an almost inevitable tendency to temporize and to minimize any surgical procedure when the treatment of anal fissure is considered routinely an office procedure. There are also certain objections to the employment of the various agents for prolonged anesthesia which have already been discussed. Their true value will be learned only by further investigation and use. In the absence of evidence of the above criteria for operative interference nonsurgical methods of treatment are worthy of trial. If such treatment fails, radical operation should be employed here also.

It has frequently been considered that the cardinal principle in treatment of anal fissure is rest. For this purpose divulsion of the sphincter was employed. While still used by some,^{7, 109, 123} it has been increasingly recognized that such a procedure is illogical and undesirable. Buie²⁸ considers that this practice, along with cauterization operation for hemorrhoids, poorly conceived diagnostic methods, and either poor postoperative management or none at all, has retarded the advance of anorectal surgery a full generation. More recently employed for the purpose of rest have been various agents for prolonged anesthesia, both in aqueous and in oily solutions. These agents have already been discussed under anesthesia and need not be reviewed here. From 3 to 10 c.c. of such a solution is injected beneath the fissure and into the sphincter on either side through a single needle punc-

a plane which is more or less flat, the posterior anal and rectal walls meet at right angles. Moreover, because the rectal ampulla curves around in the hollow of the sacrum, the descending fecal mass thrusts against the posterior wall and practically the entire expulsive force is exerted on the posterior rectal wall just above the posterior anal margin, on that portion of the anal wall with the least support.

With due appreciation of the importance of anatomic structure in the occurrence of fissure-in-ano, it is nevertheless being increasingly recognized that infection originating in an anal crypt is a primary factor in its development. Mounsey¹³⁴ recognizes crypt infection as the starting point of fissure-in-ano in 20 per cent of cases. Speare and Mabrey¹⁷³ consider it important in the pathogenesis. Fansler⁵⁰ describes a downward superficial spread of infection from a crypt rendering the "mucosa" friable with subsequent splitting caused by slight traumatization. Bacon⁷ refers to cryptitis as a usually "associated condition." Buie²⁸ considers that infection originating in a crypt is the primary cause, with trauma the inciting factor. I believe that recognition of infection in an anal crypt or an anal duct as the underlying cause of chronic anal fissure is of fundamental importance in the treatment of this condition. An inflammatory process spreading downward from a crypt renders friable the overlying anal skin, causing splitting by the ordinary trauma of defecation. This split often does not occur directly over the crypt but distal to it. It also frequently does not reach to the outermost limits of the inflammatory spread so that a pocket may develop at the distal end of the fissure. This pocket and the continued reinfection from the superimposed crypt are two important reasons for the chronicity of the condition. The mechanical factors enumerated above are undoubtedly significant in the explanation of the high percentage of fissures occurring in the posterior midline. But it has never been shown that patients who have a fissure-in-ano have been subjected to greater defecatory trauma than countless individuals who never develop such a fissure.

Treatment of Anal Fissure.—In discussion of the treatment of anal fissure, immediate differentiation must be made between the acute and the chronic fissure. An acute fissure is frequently the result of a simple mechanical splitting of the anal skin and may be healed by many types of simple local treatment or may heal with no treatment at all. Many of the cures by nonsurgical methods enthusiastically reported today owe their success in part at least to their effectiveness in this type of fissure. It is my firm conviction that with greater recognition of the theory that every chronic fissure-in-ano is the result of a downward spread of subcutaneous infection from an anal crypt, uniformly satisfactory and rational treatment will ensue. Some types of procedure, advocated consciously or unconsciously, satisfactorily effect rational cure on the basis of this theory of etiology. But emphasis

of the continuity of the rectal wall by granulomatous or neoplastic disease, the fistula being secondary to one or another primary specific disease of the rectum. An anal fistula is the result of infection originating always in the region of the anal crypts. The fistulous opening at the point of origin Buie terms the "primary" opening and the terminal opening he designates as "secondary." This terminology accords with the facts and eliminates the confusion which may occur when the secondary opening, formerly called the external opening, happens to be internal.

Among the various etiologic factors listed by many of the textbooks on anorectal disease are irritation from clothing or harsh detergents; infections in sebaceous glands and hair follicles; abrasions, tears or wounds of the anal or perianal skin or of the rectal mucosa; infection of internal or external hemorrhoids; rectal or anal ulcers; infection primary in the prostate, seminal vesicles, urethra, broad ligament and appendix; and lymphatic- and blood-born infections. Some of these books mention the possibility of primary infection in the anal crypts; others do not. However, recognition of the importance of these crypts as the primary site of infection has been gradually increasing in the past decade.^{6, 15, 39, 167, 177} The ultimate recognition of this fact is expressed by Buie²⁸ in the assertion that all abscesses of anal origin come from a source within the anal crypts and that the primary (internal) opening of every fistula-in-ano is always within the crypts of Morgagni. Trauma may be an inciting cause of the original crypt infection. Lockhart-Mummery^{108, 110} and others^{79, 182} have called attention to the anal ducts or vestigial "intramuscular glands" as the frequent site of origin for anal abscesses and fistula. These glands, opening into the base of the anal crypts, may extend a variable distance through the sphincter muscles and at times may actually reach the ischiorectal fossa. I consider these anal ducts of great etiologic significance in the development of anal abscess and fistula in infants. Although these are commonly considered rare in the newborn, they are of fairly frequent occurrence in my experience, having three such infants under 4 months of age in my care at the present time. Two of these patients had two separate complete fistulas which had persisted following the development of anal abscesses within the first two or three weeks of life. Histologic examination revealed a glandular epithelial lining in portions of the fistulous tracts.

The role of tuberculosis in the development of anal abscess and fistula has long been a subject of much discussion. The incidence of tuberculous fistulas reported in the literature varies from 1.4 per cent to 61 per cent.³¹ A wide variation (4 to 100 per cent) is noted in the incidence of tuberculous fistulas among patients with pulmonary tuberculosis.³¹ These extremely divergent reports are in large part dependent upon the criteria of diagnosis. Diagnosis by characteristic

ture. Favorable reports on this method of treatment of anal fissure have been numerous in the literature.^{67, 73, 83, 104, 149, 173, 187}

Operative Procedures.—Numerous methods of surgical treatment are employed: incision through the ulcer carried out onto the perianal skin, with or without division of a variable amount of the external sphincter muscle; conservative excision of the margins of the fissure with little if any emphasis placed upon adequate external drainage; and more radical, complete excision of the entire fissure and its bed with triangular excision of skin distally to obtain suitable external drainage. Gabriel⁵⁶ has emphasized the necessity of triangular excision, the apex of the triangle at the mucocutaneous line, the base well outside the anal verge so that healing will occur from above down, the last area to heal being outside the anus. This sound principle has been utilized by others.^{7, 28, 50, 134, 172} The triangular excision should include the superimposed crypt. Buie's operation²⁸ adequately does this. The routine suture of the free edge of mucous membrane to the sphincter is supposed to facilitate prompt healing. Excision should include all fibrous tissue down to the surface of the sphincter muscle. If any contracture is noted as the result of deeper fibrosis in the sphincter itself, this may be incised or gently dilated. Blaisdell¹⁸ recommends incision of the bar formed by the circular fibers of the subcutaneous portion of the external sphincter muscle. This may well be done to assure perfect distal drainage. By operation based upon the methods of Gabriel, Buie, and Blaisdell it is possible to remove the primarily infected anal crypt, the distal pocket of subcutaneous infection, and the constricting band of fibrous tissue which may be present, with provision for correct healing of the wound from above downward. Such a procedure will be found most satisfactory in the permanent cure of anal fissure. Careful postoperative care is essential to uniformly correct healing. This is similar to that described for hemorrhoidectomy. The cardinal object of such treatment is maintenance at all times of adequate distal drainage.

ANAL ABSCESS AND ANAL FISTULA

Pathogenesis.—Anal abscess and anal fistula represent successive stages in a common infectious process and may well be considered together in discussion of their pathogenicity. Operation for fistula-in-ano is second only to trephining as the oldest procedure known to surgery.¹⁰⁸ The many recurrences and the many tragedies of permanent impairment of sphincter control that still occur following operation bear witness to the fact that even today essential knowledge of pathogenesis and proper procedure is not widespread.

Certain desirable changes and interpretations in nomenclature have been suggested by Buie.^{27, 28} "Anal fistula" and "rectal fistula" are not synonymous. A rectal fistula develops as the result of destruction

feasible as a definite aid in overcoming the ravages of pulmonary tuberculosis. Chisholm and Gauss³⁸ are highly optimistic about surgery, reporting 98 per cent clinically cured in six to twelve weeks in a series of 71 cases.

Attention has been called to the occasional development of malignancy in fistulous tracts by Rosser¹⁵⁵ and others.^{33, 52, 101, 106, 113, 129, 137, 191}

Treatment of Anal Abscess.—Delay in operating for anal abscess until fluctuation and pointing occurs is advised by a few.^{26, 28, 39} However, many authorities^{7, 56, 71, 109} emphatically plead for early wide incision. It is believed that delay allows extension of the suppurative process with consequent delay in healing and the certainty of fistula formation. The hope is held that by early drainage there may be a lesser probability of fistula formation. The diagnosis of early abscess formation by bidigital examination before the development of external evidence of its presence is emphasized by Smith.¹⁷⁰ Operation under gas-oxygen, low spinal or sacral block anesthesia is almost universally advised. Emphasis is placed upon adequate incision for complete, rapid, and continued drainage. The old-time radial incision is poorly devised for this purpose. For subtegumentary and ischiorectal abscesses some advise tangential or T-shaped incision,¹⁰³ others suggest always an anteroposterior incision with excision of skin on the lateral border of the incision for continued drainage.⁷ Still others^{28, 56} employ a cruciform incision, cutting away the skin and subcutaneous tissue between the crossed incisions to leave a roughly circular opening. Packing of the abscess cavity is considered contraindicated and usually a small iodoform wick or rubber drain is inserted for twenty-four to forty-eight hours. Moist heat by wet packs or Sitz baths should be employed as early as is possible. Any attempt to complete the incision, as for a fistulectomy, is discouraged, although this may occasionally be done in small subtegumentary abscesses.¹⁷⁰ Hillemand and co-workers⁹¹ employ x-ray (100 r. two to three times) and claim many cures without fistula formation. The rationale and justification of such a procedure appears extremely doubtful. For submucosal abscesses longitudinal incision through the mucous membrane the entire length of the abscess cavity is universally employed. For pelvirectal abscesses Hibschman⁸⁹ objects to the forcing of a clamp through the levator ani muscle after traversing the ischiorectal space, warning of subsequent levator hernia. He has devised an approach made through an anteroposterior midline incision between the anus and the coccyx with division of the coccygeal portion of the external sphincter into two longitudinal bundles, and blunt dissection through the rectococcygeus portion of the levator ani muscle into the retrorectal or lateral pelvirectal spaces.

Treatment of Anal Fistula.—Fistula operation may be more difficult than other rectal operation, not excluding operation for rectal cancer,

appearance of the fistula is considered by most authorities to be unreliable. Others^{117, 161} claim that they are easily distinguishable. Diagnosis from the histologic appearance of the tissue is considered unsatisfactory. Gabriel⁵⁵ has shown that demonstration of the tubercle bacilli in the tissues is difficult and unreliable. This authority believes that accurate diagnosis is best made by animal inoculation. Magath and Feldman¹¹⁴ have found that guinea pig inoculation is more reliable than cultural methods. Chisholm and Gauss,³⁸ after extensive study of the literature, concluded that probably from 3 to 5 per cent of anal fistulas are tuberculous. After careful study by inoculation methods, Gabriel⁵⁵ believes that about 15 per cent are tuberculous. In a recent study of over 200 consecutive cases by intraperitoneal and subcutaneous inoculation of guinea pigs, Buie and co-workers³¹ obtained positive results in 11.3 per cent of cases, although microscopic study of many sections of tissue proved the presence of tuberculosis in only 6.6 per cent of cases. A definite tuberculous focus was present in 77.3 per cent of his cases of tuberculous fistula.

While opinion is not unanimous, it is generally agreed that a tuberculous anal fistula should be excised. Lockhart-Mummery¹¹⁰ believes that it is useless to expect healing in a patient who has active tuberculosis in the lungs or elsewhere and advises conservative treatment by establishing satisfactory drainage and sending the patient to a sanatorium. Gabriel⁵⁶ recommends operation for a superficial fistula but says that on no account should any extensive operation involving division of the sphincter be performed. Shields¹⁶¹ advises operation even if the pulmonary lesion is severe. Marino¹¹⁷ and Gerendasy⁶⁰ maintain that removal of the specific focus adds to the patient's comfort and enhances the efficiency of the general treatment of pulmonary tuberculosis. Marino has shown that postoperative healing takes twice as long if the patient has a positive sputum and he believes that the optimum time for operation is when the sputum is negative. He prefers excision with the scalpel to cautery or diathermy excision for cleaner, quicker healing. Gerendasy considers operation indicated even in the presence of a positive sputum. He also prefers operation with the knife if all diseased tissue can be clearly eliminated. Otherwise he prefers the diathermy knife. Hirschman⁹⁵ sears the tract thoroughly with the electrocautery or glacial acetic acid. Buie and co-workers³¹ have found that healing is definitely slower in tuberculous fistulas. He recommends conservative measures when pulmonary disease is a present menace to life, but even in such patients fistulotomy should be considered when the condition persists in troublesome form. This may sometimes actually save the patient's life. When a patient is not in such an extremely serious condition this authority believes that it is advisable to wait until the pulmonary lesion has become quiescent, but excision should be performed as soon as it is

this line or more than 5 cm. away from the anus anterior to this line have their internal openings at the posterior commissure.

The fundamental principle of operation is the division of all overlying tissue down to the main fistulous tract, excision of the tract, excision of all ramifications of the tract, and adequate excision of skin laterally and distally to assure proper external drainage not only for the time being but until complete healing has taken place. There is still considerable difference of opinion in regard to the problem of division of the sphincter muscles. Complete division is sometimes necessary for the cure of a fistula. There is general agreement that when such division is done a single straight incision should be made at right angles to the fibers of the muscle. It is also essential that the sphincter be cut at only one place. Buie²⁸ disagrees with both of these principles. Opinions differ concerning division of the muscle at the time of the primary operation. Some authorities believe that this should be done as a second-stage procedure at a later date. Cattell³⁶ and Buie,²⁸ both authorities of considerable experience, maintain that two-stage operation is not necessary. They state that if operation is properly done both sphincters can be safely divided and the entire tract excised without loss of sphincter control. The elimination of packing and adequate postoperative care of the wound are considered essential to this success. On the other hand, Lockhart-Mummery¹⁰⁹ advises that the external sphincter never be cut completely at the primary operation but that this be postponed two or three weeks until the muscle is held firmly in the surrounding fibrous tissue so that it will be limited in its retraction after division. He attaches no importance to the internal sphincter in defecatory control and says that this may be cut with impunity. Swinton¹⁷⁷ advocates two-stage operation when all or nearly all of the sphincter must be divided. Gabriel⁵⁶ recommends this procedure even when the muscle is to be partially divided. Allen and Haskell² report the use of a two-stage procedure in 119 out of a series of 266 cases with good union of the muscle without deformity. In my experience secondary division of the sphincter is very occasionally indicated. This does not depend primarily upon how much of the muscle must be divided but upon how much support remains above and behind the muscle. In the case of a very large, deep cavity in which there is no support for the muscle and healing is to be inevitably a prolonged process immediate division of the sphincter may result in deep fixation of the cut edges of the muscle. Ultimately there then may be a trough or groove extending the length of the anal canal which may interfere with perfect functional closure of the canal. In those cases in which there is no such deep cavity or in which sufficient scar tissue support can be left immediately above the level of the ano-rectal line complete division of the sphincter is done with impunity. In the employment of a two-stage procedure the

according to Lockhart-Mummery.¹¹⁰ He says that more surgeons' reputations are damaged by unsuccessful operations for fistula than by laparotomy. The bad results of laparotomy are buried with flowers but the fistulas go around the world exhibiting the unsuccessful results of treatment.

Nonsurgical ablation of the fistulous tract by chemicals has been practically completely discarded. The use of a tight ligature or seton to cut through the intervening tissues between the tract and the skin has also been almost wholly abandoned. Recently, however, the use of the elastic ligature for this purpose has been revived by Rochet and Violet.¹⁵² Modification of this procedure using an elastic snare rarely has been employed.^{61, 102} At the present time consensus of opinion is overwhelmingly in favor of complete excision of the fistulous tract. The importance of adequate muscle relaxation by suitable anesthesia has already been considered. Sufficient time should elapse after drainage of an acute abscess to allow the abscess cavity to shrink down to a chronic fibrous tract before excision is performed.

The first important step in operation is determination of the site of the primary or internal opening which is in one or another of the anal crypts. In the simpler varieties of fistula careful palpation will often reveal the course of the tract. The actual site of the primary opening may be palpable as a fibrotic depression or may be discernible by an area of deep ulceration or the presence of a small tuft of granulation tissue. Finally, careful exploration of the crypts with a hooked probe will locate the primary opening in the vast majority of cases. Probing of the tract from the external or secondary opening is permissible but this should be done with the most gentle pressure with a blunt probe in order to avoid making false passages or a false internal opening. In the event that these methods fail to localize the primary opening, it is recommended²⁸ that the tract be laid open from the outside as far as a probe can be easily passed, following which it is usually possible to determine readily the further course of the tract. The use of various dyes (methylene blue, iodine, potassium permanganate, mixtures of methylene blue and hydrogen peroxide) for identification of the tract and of the primary opening is recommended by some.^{15, 61, 95, 166, 177} Others^{28, 56, 60, 109, 161} definitely disapprove of this practice, claiming that its use may at times mask the true extent of the disease by escaping and staining the surrounding tissue, and insisting that the differentiation between diseased and healthy tissue is more readily made without the interference of artificial coloring. I am in thorough accord with the latter group. In determination of the primary opening some assistance may be gained from "Salmon's Law":¹⁷⁷ When the external opening of a fistula is within 5 cm. of the anus and anterior to a transverse line crossing the center of the anus, the internal opening will be found radially opposite; most fistulas with the external opening posterior to

or hypertrophied papillae; (3) excision of all elastic membrane or scar, recreating the cavity which existed immediately following the fistulectomy in such a manner that the postoperative management will produce the proper kind of scar, to which the remnants of the sphincter can adhere and close the rectal outlet.

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entire tract is laid open and excised with the exception of the sphincter muscle. A seton of nonabsorbable material is tied loosely around the muscle. When the underlying cavity has filled in sufficiently to give good fibrous support, the muscle included in the seton is divided by simple incision.

Adequate postoperative care is of great importance. Prolonged packing of the wound interferes with the desired collapse of the walls of the cavity and with optimal healing. All packing should be removed by the third day. Free use of moist heat by hot packs or Sitz baths facilitates cleanliness, diminishes infection, and encourages healing. Nonirritating antiseptic solutions may be used. Exterior drainage must be maintained at all times until the wound finally heals.

Although some authorities advocate the use of the cautery for fistula operation,¹⁶⁶ many believe that it causes unnecessary delay in healing and prefer sharp knife dissection.

ANAL INCONTINENCE

The restoration of function in sphincter incontinence, whether due to damage to the nerve supply or to direct or operative injury to the muscle itself, is a serious problem. To let well enough alone is the frequent and often wise solution for the surgeon. But this answer to the problem is of little comfort to the miserable individual who bears the disability. Surgical repair should never be undertaken lightly. Plastic operations upon the muscle itself are most difficult because of the frequent presence of extensive scar tissue and fibrous degeneration of the muscle. A plastic procedure apparently perfect at the time of operation may be completely nullified by the likely development of infection in the wound.

Wreden¹⁹⁰ and Stone,¹⁷⁵ in 1929, reported a method of reconstruction of voluntary control by the use of double fascial slings passed around the anal canal and harnessed to the gluteus maximus muscle on either side. Stone¹⁷⁶ in 1931 reported additional cases in which a slightly modified procedure was employed. In a total of 11 cases treated by this method 5 were very successful, 4 almost entirely successful, 1 only slightly beneficial, and 1 a complete failure. Voluntary tightening of the interlocking fascial slings was supposedly attained by contraction of the glutei. It would appear more probable that the success of this method of voluntary control is achieved by the upward pull of the anal canal by the levator ani muscles with the lateral ends of the fascial strips held fixed by contraction of the glutei. In such event satisfactory voluntary control is dependent upon the presence of levator function.

Buie²⁸ considers three principles in operation for postoperative incontinence: (1) eradication of any residual sinuses or abscesses; (2) removal of any deformities, such as hemorrhoids, prolapsing mucosa.

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Review of Recent Meetings

REPORT OF THE MEETING OF THE SOCIETY FOR EXPERIMENTAL PATHOLOGY, APRIL 26-29, 1939, TORONTO, ONTARIO

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AT THE Toronto meeting of the Society for Experimental Pathology (April 26 to 29), a number of important papers were presented. Only a few of them can be enumerated here.

G. A. Bennett and M. Shaffer, Boston, Mass., reported an interesting study on the passage of foreign proteins from the circulating blood into joints and other body cavities, including the anterior chamber of the eye and the spinal cord cavity. These workers succeeded in demonstrating a differential permeability to proteins in the various body cavities. From the blood stream a detectable concentration of egg albumen or horse serum accumulated into joints. The concentration in the aqueous humor was definitely lower. In the majority of instances none of these proteins reached the spinal fluid. They interpret their results as a possible explanation for the higher protein concentration of synovial fluid than that of spinal fluid or of aqueous humor. It is perhaps questionable whether their findings explain the high protein concentration of long-standing joint effusions, inasmuch as inflammatory exudates, in general, reveal a high concentration of proteins owing to increased capillary permeability. These investigators likewise pointed out, curiously enough, that, whereas egg albumen was rapidly excreted through the kidney, horse serum failed usually to appear in the urine. This raises various questions pertaining to differential renal function. Their investigations with pneumococci Type III likewise add further support to the findings with proteins, indicating again the high physiologic permeability of synovial structures for elements contained in the circulating blood. These studies throw considerable light on the comparative permeability of several important body cavities.

D. H. Sprunt and S. McDearman, Durham, N. C., reported studies showing an increased resistance to infection with vaccinia by the administration of estrogenic hormone in castrated or pseudopregnant female rabbits.

H. L. Stewart and B. F. Jones, Cambridge, Mass., described the curious occurrence of a spontaneous disease involving the cecum in rats. The condition is virtually an ulcerative cecitis with involvement of adjacent lymph nodes. The lymph stasis which they described perhaps may be referable in part to the conspicuous fibrinous deposits in distended lymph channels, inducing thus a partial lymphatic blockade.

Owen H. Wangensteen and Clarence Dennis, Minneapolis, Minn., presented an extremely interesting concept on the obstructive origin of appendicitis in man. Their observations seem to indicate that the vermiform appendix secretes fluid.

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were tumors in the lungs, liver, and brain, but no tumor in any of the pelvic organs. The uterus, tubes, and ovaries were examined carefully by sections about 3 mm. in thickness. No primary growth could be found. The uterus showed a very marked decidual reaction, such as occurs in ectopic pregnancy. There was luteinization of the ovarian follicles. Pregnancy cells were demonstrable in the hypophysis. Fourteen months before her death the patient had given birth to a normal child. Following this pregnancy, there was intermittent bleeding of small amount for ten months. During the last four months of her life, she had symptoms largely referable to a tumor of the brain.

3. Lawrence W. Smith, Philadelphia, Pa.: **Effect of Reduced Temperatures on Carcinoma.**—Smith was able to produce striking regression of superficial tumors by prolonged application of cold to the tumor. Also, in two cases of generalized metastases he obtained striking relief of pain and regression of the tumors by repeated lowering of the body temperature of the patient down to a rectal temperature of 95°. One patient who had generalized metastases from a carcinoma of the breast was apparently well two years later. The improvement in these two cases was very impressive.

4. Egon Lorenz (by invitation) and Harold L. Stewart (by invitation), Washington, D. C.: **Effect of Long-Continued Feeding of 1:2:5:6 Dibenzanthracene to Mice.**—Long-continued feeding of dibenzanthracene to mice produced no tumors in the intestinal tract, and only an occasional tumor of the lung developed. Studies of the various organs indicated that the hydrocarbon was not absorbed from the intestine.

5. Michael Levine, New York, N. Y.: **The Cytology of 1:2:5:6 Dibenzanthracene Mouse Tumors.**—The author transplanted dibenzanthracene tumors in one instance for fourteen generations and in another for twenty-two generations. The tumors at first were fibrosarcomas for several generations and then changed to a foam cell type of tumor. In later generations they returned to the fibroblastic structure. The author thought these variations were due to accidental selection of certain tumor cells in the transplant.

6. Arnold M. Seligman (by invitation) and M. J. Shear (by invitation), Cambridge, Mass.: **Studies in Carcinogenesis. VIII. Experimental Production of Brain Tumors in Mice With Methylcholanthrene.**—The authors implanted small pellets of methylcholanthrene in the cerebral cortex of mice. They obtained thirteen tumors after 200 days. A large variety of brain tumors was represented: fibrosarcoma, spongioblastoma, oligodendroglioma, ependymoma, and neuroepithelioma. The various types were illustrated convincingly by lantern slides.

7. Ira T. Nathanson and Darrel T. Shaw (by invitation), Boston, Mass.: **The Effect of Testosterone Propionate on the Development and Growth of Spontaneous Mammary Carcinoma in Female Mice.**—By injections of testosterone the authors were able to decrease the incidence of spontaneous carcinoma of the breast in female mice, but testosterone had no effect on tumors already established.

8. Wilton R. Earle (by invitation) and Carl Voegtlin, Washington, D. C.: **Further Observations on the Mode of Action of Methylcholanthrene on Cultures of Normal Tissues.**—Methylcholanthrene added to cultures of normal tissues caused some suppression of the rate of growth.

9. George Gey (by invitation), Margaret R. Lewis (by invitation), and Margaret K. Gey (by invitation), Baltimore, Md.: **Continuous Cultures of Blood Cell Tumors and Their Transplantability.**—Leucemic blood cells are maintained satisfactorily in tissue cultures. The culture was transplantable at any time

The secretion pressure of this fluid may reach heights approaching that of the systolic level of blood pressure. The temporary obstruction resulting from such fluid secretion may contribute to the histopathologic picture of acute appendicitis. Such an interpretation is highly instructive. It is now well known that inflammatory edema is probably largely referable to the establishment of an effective lymphatic blockade that prevents the rapid diffusion of excessive fluid, which in turn has permeated from vascular channels. The increase in secretory activity of the diseased appendix, by inducing a rise in pressure, perhaps can temporarily interfere with the local capillary filtration equilibrium. This would be conducive to anoxemia and inflammation. A knowledge of the mechanism of this increased fluid secretion would be valuable in an endeavor to elucidate further the pathogenesis of appendicitis.

D. R. Coman, Philadelphia, Pa., reported some interesting observations on chemotaxis by studying the nature of substances attracting or repelling the slime mold. The behavior of this mold, *Physarum polycephalum*, resembles that of an enormous leucocyte which manifests both positive and negative chemotactic reactions. Owing to its size, it can readily be studied with the naked eye. Coman found that this organism was invariably repelled by HCl and NaOH at definite concentrations. The effect was entirely referable to the H and OH ions. On the other hand, dextrose induced positive chemotaxis; whereas, insulin or crystallized egg albumen was indifferent. The conclusions drawn refer chemotaxis to a subtle selective reaction rather than to mere pH concentration or surface activity of a substance. The contributory part of this work seems to be the introduction of a new convenient tool in the form of a large visible organism which seems, nevertheless, to be similar in its behavior to a leucocyte, but which is evidently considerably simpler for the study of a complex biological property.

Finally, V. Menkin, Boston, Mass., reported observations concerning the mechanism of leucocytosis with inflammation. He was able to demonstrate the presence of a leucocytosis-promoting factor in inflammatory exudates. Leucotoxin induces increased capillary permeability and leucocytic migration into injured tissue; but it fails to alter the level of leucocytes in the blood stream. The leucocytosis-promoting factor induces a prompt rise in the leucocyte counts of otherwise normal dogs. This factor is thermolabile and essentially nondialyzable.

REPORT OF THE MEETING OF THE AMERICAN ASSOCIATION FOR CANCER RESEARCH, APRIL 5 AND 6, 1939 RICHMOND, VA.

E. T. BELL, M.D., MINNEAPOLIS, MINN.

(From the Department of Pathology, University of Minnesota Medical School)

1. R. Schrek, Hines, Ill.: **The Innate and Clinical Malignancy of Cutaneous Carcinomas.**—Basal cell carcinomas have a much longer clinical duration than squamous cell carcinomas of the skin. In a large group there was a 20 per cent fatality from squamous cell tumors and much lower death rate from the basal cell growths.

2. Lawrence Berman (by invitation) and E. T. Bell, Minneapolis, Minn.: **Extragenital Chorioepithelioma.**—Chorioepithelioma was reported in which there

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19. S. G. Warner and M. C. Reinhard, Buffalo: **The Effect of X-ray on a Transplantable Tumor of Known Genetic Constitution.**—A tumor, originating spontaneously in a stock of brown mice, grew in about 100 per cent of transplants in mice of the same strain but failed to grow when transplanted into the C57 black strain. However, when the spontaneous tumor was radiated with doses of 50 to 100 r., it could then be transplanted successfully into the C57 strain. The authors thought that they had produced a genetic change in the tumor.

20. Warren H. Lewis, Baltimore, Md.: **Normal and Malignant Cells.**—Moving pictures were shown illustrating the differences in the mobility of various forms of malignant cells.

21. Louis F. Fieser (by invitation), Cambridge, Mass.: **Chemical Studies of Carcinogenic Hydrocarbons.**—Fieser discussed the chemical structure of the various carcinogenic hydrocarbons. He stated that he had new methods of synthesizing these hydrocarbons and that some of these, notably benzpyrene, were available commercially. Efforts are being made to conjugate hydrocarbons to protein in the hope of producing antigenic substances. Shifting of the methyl group changes the carcinogenic activity of the hydrocarbon. A large number of new compounds were being experimented with.

22. Wm. S. Murray, Buffalo, N. Y.: **Is the Transmission of Mammary Cancer Susceptibility Mendelian in Character?**—Murray pointed out that it is very difficult to get a strain of mice entirely free from carcinoma of the breast. He had the C57 black strain which at first gave no cancers but now gives a few. Reciprocal crosses of the low cancer strain with a high cancer of the breast strain gave twice as many cancers when the mother was from the high cancer stock. By back-crossing continuously with a male parent of the high cancer strain, he finally obtained mice in which he computed that the chromatin was practically the same as that of the original parent of high cancer stock. However, these mice obtained in this way had a very low incidence of cancer of the breast. He concluded that mammary cancer is not transmitted through the chromosomes and is therefore not Mendelian.

23. John J. Bittner, Bar Harbor, Me.: **The Possible Method of Transmission of Breast Cancer Susceptibility in Mice.**—Bittner gave the results of further studies of the frequency of cancer in mice of a high cancer stock nursed by low cancer mothers. When the mice of the high cancer strain were taken immediately after birth and fostered by the low cancer mother, the incidence of cancer was only 1 per cent. When mice of the low cancer stock were fostered by a high cancer mother, the incidence of cancer was 11 per cent. He thinks, therefore, that the milk is a very strong influence in the development of cancer of the breast in mice.

24. Halsey J. Bagg and John Jackson (by invitation), New York, N. Y.: **A Cancer Line in Mice Derived From Low Tumor Strain (C57 Black).**—Bagg, in an experiment carried on over a period of four years, has developed a strain of mice from the low cancer strain (C57) in which 37 per cent of the breeding females developed cancer. This strain was obtained by selection from mice that developed spontaneous cancer of the breast.

25. C. P. Rhoads (by invitation), New York, N. Y.: **The Natural Defense Mechanism Against Experimental Carcinogenesis.**—Rhoads believes that the relative insusceptibility of the rabbit and the rat to dibenzanthracene is due to their greater ability to convert this hydrocarbon into a harmless substance.

and would produce leucemia in susceptible animals. A moving picture was shown illustrating the movements of lymphoblasts and monocytes in the cultures. They were unable to maintain a continuous culture of normal leucocytes, but with the malignant blood cells they were successful.

10. F. N. Craig (by invitation), J. M. Muus (by invitation), and W. T. Salter, Boston, Mass.: **The Metabolism of Mouse Sarcomas 180 Growing at Different Rates.**—The metabolism of slowly growing and rapidly growing mouse sarcomas was studied. There was no difference in the consumption of lactic acid, but less oxygen was used by the slowly growing tumors. The metabolism failed to reflect the rate of growth accurately.

11. Arthur L. Amolsch (by invitation), Detroit, Mich.: **Mixed Mesodermal Tumors of the Female Genitals.**—The author demonstrated polypoid uterine tumors with a very complex structure. The tumors showed areas of myxoma, areas of cartilage, and areas of rhabdomyoma.

12. Shields Warren, Boston, Mass.: **The Prognostic Value of the Response to Radiation in Carcinoma of the Cervix.**—A series of cases of carcinoma of the cervix were treated by radiation and biopsies were taken from time to time to determine the effect of the radiation. The biopsies showed that some tumors did not respond to radiotherapy. It was advised that such growths be removed surgically. The histologic grade of the tumor had no relation to its radiosensitivity.

13. Isabel M. Scharnagel, New York, N. Y.: **Newer Methods in Differential Diagnosis of Mammary Tumors.**—The author claimed the correct diagnosis of 119 tumors of the breast by x-ray examination. She recommended x-ray as a valuable means of distinguishing benign from malignant tumors of the breast.

14. Kenneth M. Lynch, Charleston, S. C.: **Carcinoma of Lung in Asbestos Silicosis.**—In 35 cases of asbestosis of the lungs the author found 2 primary carcinomas of the lung. In the literature these tumors are reported as being mainly of the squamous cell type but some are glandular.

15. J. S. McCartney, Minneapolis, Minn.: **Case of Granulosa Cell Carcinoma of Ovary.**—In a patient 57 years of age a granulosa cell tumor of the ovary was removed six months after the onset of symptoms. Seven years later, when the patient was 64 years of age, there was a recurrence of the tumor and the patient died of metastases. Post-mortem examination showed metastases in the peritoneum, lymph nodes, and brain.

16. Wm. J. Hoffman, New York, N. Y.: **Hormone Therapy of Male Breast Hypertrophy.**—In several cases of gynecomastia the author was able to produce regression of the breast by treatment with testosterone. He admitted that the breast often undergoes spontaneous decrease in size, but he thought the treatment hastened this regression.

17. G. B. Mider and J. J. Morton, Rochester, N. Y.: **Skin Tumors of Mice Following a Single Application of Methylcholanthrene.**—Malignant tumors of the skin of mice were obtained after a single application of methylcholanthrene. Papillomas appeared at the site of application in thirty-one to forty-eight days. Three mice developed carcinomas of the skin in 121 and 248 days after the application; 40 per cent of the mice developed papillomas.

18. Kanematsu Sugiura, New York: **Observations on Animals Painted With Tobacco Tar.**—Tobacco tar failed to produce cancer of the skin in mice.

4. Samuel A. Goldberg, Newark, N. J.: **Splenic Neoplasms.**—Several varieties of primary neoplasms of the spleen were described, including lymphangioma, hemangioma, lymphosarcoma, and endothelioma. The author believes that metastatic tumors do not grow readily in the spleen, since he believes the splenic tissue is antagonistic to the growth of carcinoma. In the discussion, it was pointed out that metastases are even less frequent in the kidneys than in the spleen and that, therefore, the spleen probably does not exert any antagonistic influence to the growth of carcinoma.

5. Rigney D'Aunoy, Bjarne Pearson (by invitation), and Béla Halpert, New Orleans, La.: **Carcinoma of the Lung. An Analysis of 74 Necropsies.**—The authors found 74 primary carcinomas of the lung in 6,600 post-mortem examinations. In their experience carcinoma of the lung was about one-half as frequent as carcinoma of the stomach. Sixteen of the tumors were columnar cell type; 37, squamous cell carcinomas; 21, reserve cell carcinomas (apparently the authors were calling the ordinary round cell carcinoma a reserve cell type). In the discussion it was pointed out that the high incidence of primary carcinoma of the lung was probably due in part to selection in autopsies. It was held that carcinoma of the stomach occurs more than twice as frequently as primary carcinoma of the lung.

6. Amour F. Liber and James R. Lisa, New York, N. Y.: **Stromal Tumors of the Choroid Plexus.**—Two types of tumors originating in the choroid plexus were described. One growth was the ordinary papilloma, the other the stromal cell tumor. The authors paid special attention to the tumors developing from stromal cells in the plexus.

7. Gordon Ritchie, Madison, Wis.: **Metastatic Tumors of the Myocardium.**—In 3,000 post-mortem examinations a large variety of metastatic tumors were found in the myocardium. Some of the tumors reached the myocardium by way of the blood stream, others by the lymph stream, and still others by direct extension. No primary myocardial tumors were seen. No clinical symptoms were attributed to the growths in the myocardium.

8. Walter Schiller (by invitation). Chicago, Ill.: **Concepts of a New Classification of Ovarian Tumors.**—Schiller proposed a new classification of ovarian neoplasms based largely on embryology. He would distinguish one group which arises from structures within the ovary, such as fibromas, granulosa cell tumors, leiomyomas, angiomas, and luteinomas; and a second group, which develops from structures displaced into the ovary during development, such as the mesonephric tumors. He also recognized that tumors, such as the endometriomas, originated in adult life from grafting of endometrium on the ovary. In the discussion it was pointed out by Ewing that this classification has no advantages over those commonly in use, since the histologic structure of the ovarian neoplasm is frequently not characteristic of any known type. Regardless of what classification one uses, tumors will be encountered which are exceedingly difficult to diagnose accurately.

9. Herbert L. Ratcliffe, Philadelphia, Pa.: **Carcinoma of the Kidney in a Colony of Rhesus Monkeys.**—In a family of rhesus monkeys consisting of seventeen members, one parent and three offspring had hypernephromas of the kidney. The histologic structure is very similar to the ordinary hypernephromas in human beings.

10. Harry S. N. Greene, Princeton, N. J.: **The Pathology of Mammary Carcinoma of the Rabbit.**—Primary carcinomas of the breast in the rabbit were

26. **L. G. Rowntree** (by invitation), **Arthur Steinberg** (by invitation), and **W. R. Brown** (by invitation), Philadelphia, Pa.: **A Further Report on the Production of Sarcomas in Rats by the Feeding of Crude Ether Extracted Wheat-Germ Oil.**

Arthur Steinberg (by invitation), **W. R. Brown** (by invitation), and **L. G. Rowntree** (by invitation), Philadelphia, Pa.: **Pathology of Masses Produced in Rats by the Feeding of Crude Ether Extracted Wheat-Germ Oil.**

W. R. Brown (by invitation), **Arthur Steinberg** (by invitation), and **L. G. Rowntree** (by invitation), Philadelphia, Pa.: **Factors Influencing the Formation of Tumors Produced by Crude Ether Extracted Wheat-Germ Oil.**—Rowntree and his associates reported the results of their work with wheat-germ oil. They were able to obtain a large number of sarcomas in rats by oral administration of wheat-germ oil. A great many of the tumors produced had been studied microscopically and most of them were reported as spindle cell sarcomas. However, it was not clear how many of the masses produced were true tumors and how many were inflammatory masses. On the whole, the evidence presented was not convincing. Several who took part in the discussion stated that they had been unable to produce sarcomas in rats by means of wheat-germ oil.

REPORT OF THE MEETING OF THE AMERICAN ASSOCIATION OF PATHOLOGISTS AND BACTERIOLOGISTS, APRIL 6 AND 7, 1939, RICHMOND, VA.

E. T. BELL, M.D., MINNEAPOLIS, MINN.

(From the Department of Pathology, University of Minnesota Medical School)

1. **Herbert S. Reichle** and (by invitation) **John L. Work**, Cleveland, Ohio: **The Incidence and Significance of Healed Miliary Tubercles in the Liver, Spleen, and Kidneys.**—In 452 autopsies the author found 91 cases with small calcified nodules in the spleen, liver, and kidneys. These had no relation to blood vessels. Fifty per cent of the cases had tuberculosis, active or healed, in other parts of the body. In 3 of the nodules tubercle bacilli were demonstrated. Interpretation of these small miliary nodules is that they represent healed tuberculosis.

2. **William H. Feldman** and (by invitation) **A. H. Baggenstoss**, Rochester, Minn.: **The Occurrence of Virulent Tubercle Bacilli in Presumably Nontuberculous Tissues of the Lung.**—Some years ago Opie reported the finding of living tubercle bacilli in normal lung tissue. Feldman took samples from normal lung tissue, studied a portion microscopically, and injected other portions into guinea pigs. Sixteen guinea pigs were inoculated from each post mortem. Only 3 positive growths were obtained in the guinea pigs and these were from 2 individuals. The author, therefore, concludes that living tubercle bacilli are not found in normal lung tissue.

3. **Otto Saphir**, Chicago, Ill.: **Intracystic Papilloma of the Breast.**—Saphir studied fifty-eight papillomas of large ducts of the breast, most of which were associated with bleeding from the nipple. Some of the tumors were studied in serial sections. He described pseudoglandular and glandular microscopic varieties. There was also a form composed of spindle-shaped cells which he called transitional cell type. All of the papillomas are apparently benign, but the author advised mastectomy in the case of the transitional cell papillomas.

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is therefore not of reflex origin. In the dog with experimental hypertension the blood pressure falls gradually if the adrenals are removed. No elevation occurs in an animal if the arteries are constricted after removal of the adrenals. He thinks that a portion of adrenal cortex is necessary to maintain the hypertension. Goldblatt takes the position that primary hypertension is basically a disease of the vascular system of the kidneys.

15. C. C. Erickson and L. V. Dill (by invitation), Durham, N. C.: **Observations on the Effects of Renal Ischemia in Pregnant Dogs and Rabbits.**—In pregnant dogs the authors produced bilateral constriction of the renal arteries by the Goldblatt method. The dogs rapidly developed toxic symptoms similar to human eclampsia. At post-mortem examination hemorrhagic necroses of the liver were found. The changes in the kidneys were not clearly brought out. Emptying of the uterus produced relief of symptoms and survival of the animal.

In the discussion Goldblatt stated that if one first produces the constriction of the renal arteries and then allows the animals to become pregnant, the blood pressure tends to decrease as pregnancy advances. Greene spoke of spontaneous eclampsia in rabbits.

16. Hugo A. Freund, Detroit, Mich.: **Vascular Hypertension Occurring in Cases of Coarctation of the Aorta.**—Freund described five clinical cases of coarctation of the aorta. The blood pressure is always high in the upper extremities unless the heart fails. In one case the author recorded a diastolic pressure of 110 in the legs. The systolic pressure in the lower extremities is low, but the diastolic is as high as in the upper extremities. He agrees with Rydand that the hypertension in coarctation of the aorta is due to ischemia of the kidneys. In the discussion Goldblatt agreed with this interpretation.

17. F. W. Hartman, Detroit, Mich.: **Hypertension and Kidney Lesions Produced by X-ray.**—Hartman called attention to the fact that he had produced experimental hypertension in dogs fourteen years ago by means of radiation of the kidneys. He repeated this earlier work and described the arteriolosclerosis which results from radiation of the kidneys. He stated that by this method of producing hypertension one also has arteriolosclerosis of the kidneys.

18. Irvine H. Page, Indianapolis, Ind. (by invitation), and Irving Graef, New York, N. Y.: **Hypertension Following Experimental Perinephritis Induced by Cellophane. A Preliminary Report.**—Page enclosed the kidneys in a cellophane membrane. This results in a fibrinopurulent exudate on the capsule of the kidneys. The exudate becomes organized and finally results in marked compression of the kidney, including the renal vein. The tubules undergo atrophy. He thinks that the chief cause of the atrophy is compression of the renal vein. The animals develop hypertension after this procedure. Hypertension was attributed to renal ischemia.

19. Robert Brotchner (by invitation) and E. T. Bell, Minneapolis, Minn.: **Experimental Acute Hypertension From Obstruction of the Aorta.**—The authors produced acute hypertension by stenosis and occlusion of the thoracic aorta in dogs. The blood pressure was recorded by means of a cannula in the carotid artery. Stenosis of the aorta above the origin of the celiac axis produces an average rise of 56 mm. in the systolic pressure. When the constriction is applied immediately above the kidneys, a rise of about 14 mm. takes place. With the clamp below the kidneys, the rise is only about 8 mm. Stenosis or occlusion of both renal arteries did not affect the blood pressure. It is noteworthy that the degree of hypertension corresponds with the amount of the blood that is obstructed. Ob-

is, therefore, not an ulcerative bronchitis but an inflammation in the subepithelial tissues of the bronchus. Apparently the stagnation of the bronchial secretion is the major cause of the persistence of the infection. In one case there was an adenoma of the bronchus.

26. J. S. McCartney, Minneapolis, Minn.: **Age and Site of Operation in Relation to Postoperative Pulmonary Embolism.**—McCartney showed from an extensive study that pulmonary embolism occurs much more frequently in old persons than in the young. The reason why certain operations are more often followed by pulmonary embolism than others is due to the age of the patients on whom such operations are performed. For example, operations on the prostate are nearly always performed on old men, and this is the main reason why pulmonary embolism is so frequent. On the other hand, appendectomies are more often performed on younger persons and have a lower incidence of pulmonary embolism. It was shown rather clearly that the age of the patient is more important than the site of the operation in the occurrence of pulmonary embolism.

27. Warren C. Corwin (by invitation), Philadelphia, Pa.: **The Relationship of the Insulin Hypoglycemic Reaction to Shock.**—Corwin gave evidence that the hypoglycemic reaction is not related to the phenomena of shock.

28. Sheldon A. Jacobson, Brooklyn, N. Y.: **Studies in Metaplastic Ossification.**—Jacobson pointed out that if portions of the urinary bladder of the dog are transplanted into the rectus muscle, bone and cartilage develop from the transplant. When this operation is performed in rats, however, very few positive results are obtained. In the guinea pig autoplasmic transplants of the bladder frequently resulted in the production of bone. By experimental procedures, the author was unable to influence the frequency of this osseous transformation.

29. Edwin F. Hirsch and (by invitation) Russell H. Morgan, Chicago, Ill.: **The Causal Significance to Traumatic Ossification of the Fibrocartilage in Tendon Insertions.**—Hirsch showed that fibrocartilage is present in the tendons at their bony attachments and that in myositis ossificans the formation of bone is due to a primary growth of this fibrocartilage out into the tendon of the muscle.

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REPORT ON THE MEETINGS OF THE AMERICAN SOCIETY OF
BIOLOGICAL CHEMISTS, APRIL 26-29, 1939,
TORONTO, ONTARIO

W. D. ARMSTRONG, PH.D., M.D., MINNEAPOLIS, MINN.

OF THE 160 papers presented in person or by title, those abstracted below are considered to be of interest to clinicians.

E. J. Baumann and D. B. Sprinson, Montefiore Hospital, New York, N. Y., reported thyroid deficiency in rabbits to result in an increase in the amount of circulating parathyroid hormone as demonstrated by the Hamilton and Schwartz test.

W. R. Bloor, University of Rochester, N. Y., described an improved method for the determination of adrenalin in blood. The results are accurate to 5 per cent and normal blood was found to contain 0.05 μ g. adrenalin per cubic centimeter.

Erwin Chargoff, College of Physicians and Surgeons, Columbia University, New York, N. Y., used radioactive phosphorus to study the rate of formation of phospholipids and found lecithin to be formed faster than cephalin in the intestinal tract and liver.

T. B. Coolidge, Duke University School of Medicine, Durham, N. C., found the type of van den Bergh reaction is not affected by the cholic acid content of blood and that the function of alcohol in the indirect test is purely catalytic.

E. Brand, B. Kossel, and M. Heidelberger, College of Physicians and Surgeons, Columbia University, New York, N. Y., applied Bergmann's theory of protein structure to thyroglobulin (molecular weight 675,000) and calculated that each molecule contains 5,760 amino acid residues, of which 10 are diiodotyrosine and 2 thyroxine.

D. V. Frost and C. A. Elvehjem, University of Wisconsin, Madison, Wis., found that small amounts of cobalt are required, along with iron and copper, for complete regeneration of hemoglobin in anemic dogs maintained on a milk diet.

R. B. Gibson, J. Findlayson, and W. D. Paul, State University of Iowa, Iowa City, Ia., using improved methods and procedure, have confirmed the old observation that the renal threshold for glucose is definitely lowered in late pregnancy.

O. M. Helmer and Irvine Page, Lilly Laboratory for Clinical Research, Indianapolis, Ind., have made considerable progress in the purification of rennin, the substance responsible for the hypertension of renal ischemic origin, and find it to have the properties of a protein.

Ancel Keys and H. L. Friedell, Departments of Physiology and Radiology, University of Minnesota, Minneapolis, Minn., have adapted roentgenkymography to the accurate measurement of the stroke output of the heart. The method has the advantage that it can be applied to persons incapable of cooperation. In mitral insufficiency and aortic regurgitation a comparison of the result obtained with the new method with that of the acetylene (Grollman) method gives a

quantitative measure of the leak. Roentgenkymography has been found by these workers to be of great value in the diagnosis of adhesive pericarditis and in an estimation of the improvement in function resulting from pericardiolysis.

B. F. Miller, Z. Baker, and M. J. C. Allinson, Department of Medicine, University of Chicago, Chicago, Ill., employed the method of Miller and Dubos to distinguish between true and apparent creatine and creatinine in tissues. Except for muscle, brain, and testis, the true creatine is only 15 to 70 per cent of the apparent creatine.

A. F. Morgan, J. Hendricks, and N. Shimotori, University of California, Berkeley, Calif., found a low calcium adequate phosphorus diet to prevent the onset of symptoms of hypervitaminosis D₂ and D₃ in rats.

J. Orten and Aline Orten, Wayne University, College of Medicine, Detroit, Mich., reported that a long-time protein restriction in a dietary that was otherwise adequate resulted in the development of a typical hypochromic anemia in dogs.

L. B. Pett, University of Alberta, Edmonton, Alberta, examined 1,300 persons, 1,000 of whom were university students, and found that 24 per cent exhibited signs of marked hypovitaminosis A.

H. Schneider and H. Steenback, University of Wisconsin, Madison, Wis., found a low phosphorus diet to result in the formation of calcium citrate urinary calculi. Some human urinary calculi were found to contain calcium citrate and it was suggested that this substance may play a role in the formation of the primary nidus upon which other urinary salts are precipitated.

E. Sobel and B. Sobel, Jewish Hospital, Brooklyn, N. Y., demonstrated a method for calcium determination in 0.1 c.c. of serum.

A. Sobel, H. Yuska, D. D. Petrovsky, and B. Kramer, Jewish Hospital, Brooklyn, N. Y., found a low calcium high phosphorus diet to be most effective in maintaining a low blood lead content in animals fed a constant amount of lead. The effects of vitamin D on the blood lead varied with the type of diet, but the lead in the bone ash was increased by giving this vitamin with diets of varying calcium and phosphorus contents.

Book Reviews

A Manual of Fractures and Dislocations. By Barbara Bartlett Stimson, College of Physicians and Surgeons, Columbia University, New York City. Paper. Pp. 214, with 95 illustrations. Philadelphia, 1939, Lea and Febiger. \$2.75.

This little manual summarizes well the whole field of fractures and dislocations. In the preface the author states that the handbook is intended primarily for medical students, but it could be read with profit by the general surgeon. The methods of diagnosis and treatment are those carried out by the staff of the Fracture Service at the Columbia-Presbyterian Medical Center. No attempt has been made to make this an exhaustive treatise. However, it is surprising how comprehensively the various types of fractures are reviewed in such a few pages; it is doubtful whether there is any more essential information to be added. The summaries given at the end of each section are excellent. The illustrations are clear. An index is appended. Without doubt this is one of the best outlines on the subject of fractures published to date.

Oh, Doctor! My Feet! By Dudley J. Morton. Cloth. Pp. 116, with 11 illustrations. New York, 1939, D. Appleton-Century Company. \$1.50.

The volume represents an effort on the part of the author to popularize his views on foot trouble. Dr. Morton has studied the foot and written on this subject before. His viewpoint as to the cause of foot trouble and best method of treatment has already quite widespread recognition among orthopedic surgeons.

Whether this effort to popularize the author's ideas will accomplish its purpose remains to be seen. It does graphically describe his theories and method of treatment. Whether or not treatment of foot ailments can be simplified to the extent that the author implies in this work remains to be proved. There are some useful hints as to proper shoe fitting and altogether the book deserves much attention, perhaps more among physicians than among laymen who may be misled by the implied simplicity of diagnosis and cure of all foot ailments.

The Treatment of Fractures. By Charles L. Scudder. Ed. 11. Pp. 1208, with 1717 illustrations. Philadelphia, 1938, W. B. Saunders Company.

In this volume the author has had the assistance of twenty collaborators in writing fifteen of the forty-seven chapters. A successful attempt has been made to include discussion of the various subjects closely allied to fractures. For example, discussion on dangers and precautions in roentgenologic treatment, and aspects of medicolegal relations, though brief, are included.

In the reviewer's opinion, one of the most serious defects lies in the lack of a bibliography. Only at the end of a few chapters are complete references, including recent publications, found. Throughout the book numerous references to

names are included but the scarcity of journal references is so pronounced as to be discouraging to a reader who might want to read further on some particular subject.

Compound fractures are very thoroughly discussed but it is doubtful if most surgeons would agree to the use of such meticulous care in Carrel-Dakin therapy as is presented. Factors in the pathogenesis of shock are clearly presented but a more formal and detailed description of therapeutic measures would be appropriate. The technique involved in the various steps of operations on fractures is carefully presented and illustrated. The chapters dealing with head injuries, anesthesia, fractures of facial bones, and fractures of the vertebral column are particularly well written and informative. Although many neurosurgeons would disagree with the suggestion that hypertonic solutions have but a small place in the treatment of head injuries, attention is correctly called to this possible source of disagreement. The reviewer was gratified to find the statement that wood splints were perhaps the most effective type of the various agents used in the fixation of Colles' fractures.

The insertion of Figs. 1412 and 1413 illustrating fracture of the thigh in the chapter dealing with fractures of the leg is confusing to the reader because of the difficulty in correlating them with the text, particularly with the legends accompanying them.

There is a generous number of illustrations, which consist of an appropriate ratio of photographs, drawings, and photomicrographs. They are extremely well chosen and reproduced; the fact that a great number of them are borrowed does not, of course, detract from their value.

In general, the material covers the subject of fractures very well and includes a great mass of information. The attempt to make the text practical has been extremely successful. It may conscientiously be recommended highly to the student or practitioner for a guide in fracture work.

Midwifery. By ten teachers. Cloth. Pp. 676, with 200 illustrations and 9 color plates. Baltimore, 1938, William Wood and Company. \$6.

This book, written by ten teachers and edited by Sir Comyns Berkeley, Clifford White, and Frank Cook, has been prepared primarily for students but is also a very good book for the man in practice. The illustrations are numerous and are very descriptive but the photography does not compare with that in American textbooks.

The description and illustrations for early pregnancy are very clear. The physiologic changes induced by pregnancy have not been described adequately. In the future editions this chapter should be revised thoroughly.

Under the term toxemia the authors consider toxemia, hyperemesis, and acute yellow atrophy. The description of these conditions as well as those of the toxemias is entirely from the clinical point of view. There is very little physiology presented. There seems to be confusion in regard to the various types of liver pathology occurring in eclampsia and hyperemesis. Oliguria and anuria of eclampsia are treated by decapsulation. No mention is made of hypertonic glucose solution which has eliminated anuria in toxemic patients. Medical management for 36 to 48 hours and then induction of labor by rupture of the membranes also is advised. This seems a rather long time to treat patients before inducing labor.

Anemia is treated with iron, yeast, and green vegetables.

Deliveries are usually in the lateral position, which, of course, is rarely used in this country. If packing is used in the treatment of placenta previa, only vaginal packing is used. This is contrary to the teaching that it is most important to pack the lower uterine segment; thus always a portion of the placenta is separated. The use of dettol cream on the vulva and on the pack is mentioned. This antiseptic solution is used very extensively in the British Isles but has not been well received in this country.

The classical and low cervical types of cesarean section are described. In the latter operation the fetal head is delivered with the Willet's forceps. This is far superior to the use of the volsellum forceps. Sterilization is opposed unless there are definite medical grounds for it.

The book is well written and is recommended by the reviewer.

Surgical Pathology of the Diseases of the Mouth and Jaws. By A. E. Hertzler. Cloth. Pp. 248, with 206 illustrations. Philadelphia, 1938, J. B. Lippincott Company. \$5.

This book, by the author's own admission, is the last of a series of ten monographs on various phases of surgical pathology. The scope of the work is somewhat more restricted than its title indicates. The writer has discussed in a rather individual style those conditions with which he has become acquainted through the years of an extensive country practice. As a record of experience in which the writer frequently has included his personal ideas concerning the proper diagnostic and therapeutic procedure, the book is interesting and perhaps worth while. For this very reason, however, it cannot be recommended to students as a textbook or to the practitioner as a reference book. Appended at the end of each chapter is a representative bibliography covering the material presented. Just how much value one is to attach to these references is doubtful, for in his preface the writer states that he has not read these references, but on the other hand has "adopted the more respected practice" of having his secretary copy them out of the cumulative index.

By far the most worth-while feature of the book is the wealth of excellent photographs which it contains. Most of the well-known pathologic lesions of the mouth are clearly depicted in their various phases. A number of good photomicrographs of removed specimens further embellish the book.

SURGERY

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THE ANESTHETIC MANAGEMENT OF PATIENTS WITH A HYPERACTIVE CAROTID SINUS REFLEX

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THE identification of certain intrinsic reflexes which are active in maintaining standard conditions in the vascular and respiratory systems has favored the anesthetist in his effort to minimize physiologic disturbances during clinical anesthesia. It has given him a better appreciation of the innumerable factors involved in the choice of preanesthetic drugs, anesthetic agents, and methods of their administration. This increased knowledge also has assisted the anesthetist in his attempts to remedy certain untoward reactions referable to the circulatory and respiratory systems that may occur during anesthesia. Finally, it has clarified the approach toward the selection of anesthetic procedures which provide increased safety to the patient and added conveniences during surgical manipulations which are designed to correct such abnormal functioning reflexes.

The carotid sinus, but lately identified and more recently analyzed, is among the subsidiary reflex centers which modify the functioning of the autonomic nervous system. It operates as a significant secondary mechanism for the control of cardiovascular and respiratory activity. Its importance has not been completely evaluated, but it is certain to play a prominent role in adopting adjustments of circulation and respiration to meet changing conditions of the body's external and internal environment. The reflexes are aroused by changes in the chemical composition of the blood, by variations in arterial pressure, and by mechanical stimulation, such as pressure or traction at their site, the bifurcation of the common carotid arteries.¹ The chemically aroused reflexes probably are entirely distinct from those which respond to changes in arterial tension or mechanical stimulation. The former have only a slight or secondary

effect upon circulation but an important influence upon respiration.² The latter have a significant effect upon the control of heart rate and rhythm and the general arterial tension.² The anatomic situation of the carotid receptors stimulated by biochemical changes is different from that of the pressor receptors. They lie within the carotid bodies which are located at the proximal end of the occipital artery and not throughout the carotid sinus proper. Similar receptors are present in the aortic arch.⁴ The carotid body receptors react to oxygen lack and to a much less extent to carbon dioxide excess. They are not pertinent to this discussion, which is primarily concerned with reflex effects upon circulation, and therefore will be disregarded. A previous report referred to their significance during clinical anesthesia.⁵

The carotid sinus receptors normally are influenced by changes in intrasinal pressure only. They are innervated by a branch of the glossopharyngeal nerve. Receptors sensitive to rises in arterial pressure also are found in the arch of the aorta and are believed to be innervated by a branch of the vagus. The efferent path of the sinoaortic reflexes is through the vagus and cervical sympathetics.⁶ Normally an increase in arterial tension or intrasinal pressure lowers blood pressure and decreases the heart rate, and a diminution in intrasinal pressure elevates the blood pressure and increases the heart rate. In normal subjects this endovascular control operates automatically and physiologic stimulation produced by changes in arterial tension causes only a slight and temporary change in blood pressure.³ Likewise, mechanical stimulation of the carotid sinus, unless extremely intense, as from traction or pressure, produces no appreciable effect. In the absence of abnormal clinical manifestations, the reflex is still of interest to the anesthetist. Its activity is profoundly influenced by the anesthetic drugs and techniques employed, by the trauma of operative manipulations, and by hemorrhage. Although this discussion is concerned primarily with abnormal or hyperactive carotid sinus reflexes, it may be well to point out that serious disturbances of the normal mechanism may result from anesthetic and surgical manipulations. Heymans¹ has completed experimental work to prove that factors which paralyze or seriously depress the reflex mechanism regulating or controlling blood pressure, especially the carotid sinus reflex, decrease or abolish the normal compensatory reactions of the body against arterial hypotension. He believes that one of the main causes of circulatory collapse during severe trauma, hemorrhage, high spinal anesthesia, profound inhalation narcosis with the volatile agents, and anoxemia is directly related to the paralyzing effects of these procedures on the normal carotid sinus vasopressor reflexes. Clinical observations repeatedly have borne out the suggestion that profound and lasting shock more often occurs when these factors are in effect and particularly when a combination of two or more of them is present.

The carotid sinus, like any physiologic mechanism, may cease to function normally. Abnormal reactions may be so extensive that clinical symptoms are evident. These symptoms and signs comprise the "carotid sinus syndrome."⁷ The abnormal reactions may differ. One type, referred to as the vagal, is characterized by bradycardia, asystole, arrhythmia, hypotension, and cerebral anemia. Another, the depressor reaction, ordinarily found in association with one of the other types, produces a vasomotor response with a lowered blood pressure but without significant changes in heart rate. Still another form, characterized by the clinical symptoms but without alteration in vasomotor tone or heart rate, is known as the cerebral type. All three types of reflex activity are provoked by changes in pressure at the sinus and are manifest by the clinical syndrome associated with psychic changes, "fainting spells," unconsciousness, and less frequently generalized convulsions.

Differentiation of the various types is an integral part of the diagnosis and is of especial interest to the anesthetist. Without such diagnosis the choice of preanesthetic and anesthetic drugs may not be easily made with scientific accuracy. Electrocardiographic tracings are essential in determining the vagal and vasomotor effects, but, since these effects may also occur in the cerebral type, pharmacologic tests serve best to reach an ultimate diagnosis. Atropine in therapeutic doses abolishes the vagal but has no appreciable effect upon either the depressor or cerebral types. Epinephrine and ephedrine have some effect upon both the vagal and depressor types, but they do not eliminate the cerebral response. The cerebral type is not known to be greatly improved by drug therapy.

The simple clinical test for establishing the diagnosis is accomplished by mechanical stimulation. This is best done with the patient sitting, since the reflex is more active in the upright position. The sinus, located at the angle of the bifurcation of the carotid, often may be palpated in individuals with a lean neck. A line extended along the lower angle of the jaw most often crosses the bifurcation just lateral to the sternomastoid muscle, although it may be above or below this usual position. After locating this point, moderate pressure is exerted by the fingertips, using a rotary motion for ten to thirty seconds. When the reflex is hyperactive, pallor of the face is noted, bradycardia and hypotension occur, and the patient realizes syncope is imminent. That this clinical syndrome is definitely a carotid sinus reflex abnormality may be conclusively demonstrated by a diagnostic nerve block. Such a nerve block also serves to establish an indication for surgical therapy.

The carotid sinus block is performed with the patient supine and the head extended. The level of the transverse process of the fourth cervical vertebra is located after the method described by Labat⁸ or by Wertheim and one of us.⁹ The bifurcation of the carotid artery is usually at this level and slightly anterior. After a skin wheal is raised at this point, a 50 by 7 mm. small gauge needle, unattached from the syringe, is intro-

duced. Because of the superficial location (1 to 3 cm.), caution is advised as the needle is advanced to contact the transverse process. After such contact the needle is withdrawn slightly, directed ventrally, and advanced not more than 1 cm. Pulsation of the artery is felt as it is transmitted through the needle. The syringe is then attached and, with repeated aspirations and careful stabilization of the needle to prevent puncture of the large vessels, approximately 10 c.c. of a 1 per cent solution of procaine is deposited. Light massage at the site facilitates diffusion of the injected solution about the sinus area. Successful blocking of the area frequently is accompanied by partial recurrent laryngeal nerve paralysis which is manifested by hoarseness and by a subjective sensation of mucus in the trachea with a resultant cough. This effect is to be expected with the existing anatomic relationships of the sinus and recurrent laryngeal nerve. Less frequently observed is the appearance of Horner's syndrome from paralysis of the cervical sympathetics. Some five minutes after such an injection, pressure is applied as before to elicit the reflex. If the clinical symptoms cannot be provoked after this procedure, the diagnosis is assured and the surgeon is greatly aided in determining whether periarterial sympathectomy of the bifurcation of the common carotid is indicated therapy. It should be pointed out that regional anesthesia as ordinarily performed for operations upon the neck, such as infiltration, field block, or cervical plexus block, will not eliminate the carotid sinus reflex unless some anesthetic solution is deposited near the carotid sheath at the bifurcation.

The anesthetist is interested from the practical standpoint in knowing the effects upon the sinus mechanism of drugs used therapeutically before operation, of drugs employed for preanesthetic medication, and of the anesthetic agents and techniques. Digitalis is frequently given before surgery not only for patients with coronary or myocardial disease, but also with the thought that prophylaxis for postoperative circulatory depression thereby is established. Digitalis increases the excitability of the carotid sinus reflex. Weiss has pointed out possible consequences following the use of such a drug in the presence of an abnormal reflex tending to induce arrhythmias and cardiac arrest. In such patients the application of mechanical stimulation during operation or the increased excitement of the central nervous system attending the anesthetic procedure may be potent factors in producing serious arrhythmias or even sudden deaths.⁷ It has already been stated that atropine in therapeutic doses eliminates the vagal type of abnormal reflex. Scopolamine has a similar effect. The derivatives of barbituric acid usually diminish the vagal and depressor types and the shorter acting of these drugs, such as evipal, pernocton, and pentothal, suppress them completely. Luminal in therapeutic doses and barbital have no effect upon the reflex.¹⁰ Morphine and other opiates are reported to be without effect, but clinical ob-

servations support the view that excitability of the reflexes is definitely increased with morphine as ordinarily used preoperatively.

The volatile agents used for anesthesia, ether, vinethene, and chloroform, depress the sinus activity when deep narcosis is obtained, but light anesthesia will usually increase it. The gaseous drugs, nitrous oxide, ethylene, and cyclopropane, apparently have little effect or stimulate its activity. A few observations following the use of avertin in amylene hydrate for basal narcosis indicate that the reflex is made more sensitive with these drugs. Cocaine and drugs with similar action abolish the reflex when applied locally.

The technique employed for administering drugs whose actions are dependent upon their circulation in the blood stream is without significant effect upon the reflex. The regional anesthesia methods commonly employed, except subarachnoid block, have no effect upon the carotid sinus reflex. A high spinal block, including the upper thoracic segments, often will depress its activity. Carbon dioxide and oxygen tensions in the inspired atmosphere are significant for their influence upon arterial tension. Low oxygen or high carbon dioxide tensions in the tissues are always dangerous during anesthesia and are particularly hazardous for patients with abnormal carotid sinus mechanisms.

Patients with any one or a combination of the reviewed types of abnormal carotid sinus reflexes may require anesthesia either for surgical relief of the symptoms or surgical therapy for an unrelated condition. In the former instance, the anesthetic management assumes definite importance. Following the diagnosis of the type of reflex abnormality, the anesthetist should perform a diagnostic procaine block. Such a procedure not only establishes an indication for surgical therapy, but also gives the anesthetist valuable information concerning the circulatory reactions that may be expected during the manipulation. The anesthetic regime selected for actual operation is determined after consideration of several factors. The patient must be spared pain during the procedure, but more important he must be protected against serious results from the stimulation that will be applied. Moreover, the surgeon may be assisted materially in his efforts to complete the operation conveniently with a minimum of trauma and within a short period of time. The operation consists essentially in breaking the reflex arc by stripping the adventitia of the arteries and sectioning the intercarotid nerve of Hering. The primary difficulty is the exact identification of the intercarotid nerve. To be assured that this is accomplished when the reflex is depressed by the anesthetic drugs employed, it is practically necessary to dissect completely the adventitial layer around the carotid and the lower part of its external and internal branches. This layer is very adherent and there is danger of arterial perforation. Any means to relieve the surgeon from this extensive operation and still be assured of the operation's success will be welcomed; the patient will be subjected to less trauma and

dangers from the operation will be decreased. If the surgeon is to be given such assistance, that is, if at the same time he may be assured by the anesthetist that the operation is complete at the instant when the intercarotid nerve is sectioned, an active reflex throughout the procedure is essential.

It is recommended that anesthesia during surgical therapy designed to treat "carotid sinus syndrome" be performed as follows: The patient is given no drug before anesthesia except morphine. This may be administered subcutaneously in an amount somewhat less than ordinarily would be used for preanesthetic preparation. It is important that the morphine be given not less than two hours preoperatively to avoid the resulting depression's being maximum during the procedure. Anesthesia should be induced and maintained in light first plane with one of the gases, preferably cyclopropane. Cyclopropane does not depress the reflex, permits the use of high oxygen dilutions in the anesthetic atmosphere, and facilitates the introduction of an endotracheal airway. The carbon dioxide absorption technique should be employed, since with it exact control of oxygen and carbon dioxide tensions is more convenient. Endotracheal intubation is advised to insure a patent airway, facilitate rapid control of the narcosis, and provide a functioning airway for artificial respiration if needed. Pulse and blood pressure determinations must be completed at intervals so brief as to be practically continuous. During such anesthesia, stimulation of the reflex by operative manipulations of the uninhibited sinus area will result in the circulatory signs elicited preoperatively, usually bradycardia, lowered arterial tension, and decreased pulse pressure. When sectioning of the intercarotid nerve is completed, the heart rate will increase immediately, the arterial tension will be restored to a level exceeding that preoperatively, and the pulse pressure will increase. The surgeon may then be advised that the operation is completed. It must be borne in mind that during the time of bradycardia and lowered blood pressure there is marked cerebral anemia. The patient may exhibit marked pallor and all signs which indicate syncope in the anesthetized individual. Oxygen must be used freely and the concentration of cyclopropane should be reduced to less than the amount required to anesthetize the patient before the reflex was stimulated. It is frequently advisable to perform controlled respiration by hyperventilation when the circulation is severely depressed.

The efficacy of such an anesthetic regime and the circulatory reactions that may be anticipated during operations upon the carotid sinus are well illustrated in the following case report (Fig. 1).

CASE 1.—A white male, aged 63 years; diagnosis carotid sinus syndrome, vasomotor type, hypertension and vasomotor instability. The hyperactive reflex easily elicited by pressure over the area could be paralyzed by atropinization. A diagnostic procaine block likewise eliminated the reflex response to mechanical stimulation.

Operation.—Surgical denervation of the right carotid sinus. Preanesthetic medication, morphine sulfate 0.007 gm. intravenously at 11:30 A.M. Anesthesia was induced with cyclopropane using the closed carbon dioxide absorption technique at 11:48 A.M. Six minutes after induction was begun, an oral endotracheal airway fitted with an inflatable tracheal cuff was inserted. Surgery was started at 12:00 noon with patient in first plane surgical anesthesia. The blood pressure, pulse rate, and respiratory rate during the operative procedure are shown graphically on the accompanying study record (Fig. 1). Electrocardiographic tracings were made during the procedure. They confirmed the changes in pulse rate determined by palpation. Convalescence and recovery were uneventful. Symptoms were entirely relieved.

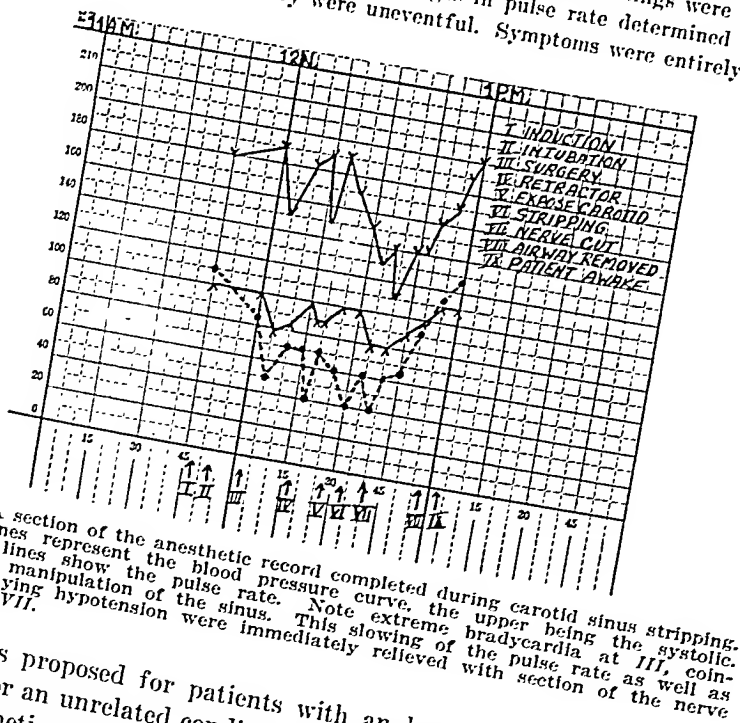


Fig. 1.—A section of the anesthetic record completed during carotid sinus stripping. The solid lines represent the blood pressure curve, the upper being the systolic. The broken lines show the pulse rate. Note extreme bradycardia at III, coincidental with manipulation of the sinus. This slowing of the pulse rate as well as the accompanying hypotension were immediately relieved with section of the nerve of Hering at VII.

Operations proposed for patients with an hyperactive carotid sinus reflex, but for an unrelated condition not involving the neck, present no serious anesthetic complication. With a diagnosis of the type of abnormal reflex, the preanesthetic medication and the anesthetic agent may be selected that will depress and those drugs avoided that will stimulate the reflex.

The patient without recognized clinical evidence of abnormal carotid sinus activity may be encountered during surgery. Such occasions are not infrequent when thyroidectomy, carotid ligation, cervical gland dissection, or incision of abscess in the anterior triangles of the neck is being done. It is suggested from clinical experience that the presence of such pathology may alter an otherwise normal reflex activity. This is particularly true of patients where infections of the neck are present. It suggests a possible explanation for the sudden deaths that are not rare following incision and drainage of such infected areas. These sudden deaths usually occur during light anesthesia with the gases and they have been reported in cases where local anesthetic agents were employed.

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and an abundance of oxygen was given. The surgeon was directed to inject procaine at the bifurcation of the left common carotid. No improvement followed the injection. A similar injection was then accomplished on the right side, followed by an immediate restoration of blood pressure and pulse rate to the level observed before manipulations were begun. Spontaneous respirations were resumed. The operation was completed and the patient had an uneventful convalescence and recovery. Later examination revealed a hyperactive carotid sinus reflex on the right side, sensitive to mechanical stimulation.

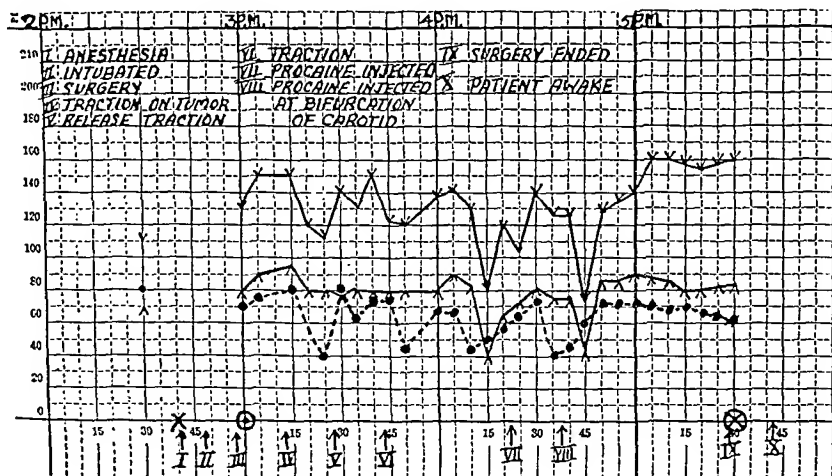


Fig. 2.—The blood pressure curve (solid lines) and pulse rates during operation to dissect tumor of neck. Traction on the tumor, as at IV, produced marked hypotension and pulse rate of 40 beats per minute. This could be reproduced whenever traction was applied. At VII, procaine (5 c.c. 1 per cent solution) was injected by surgeon to infiltrate the bifurcation of the common carotid. Response to traction on the tumor was the same. After further dissection, it was determined that injection had been incorrectly placed. Injection of similar solution in proper location (VIII) was made. Thereafter severe traction upon the tumor produced no effect.

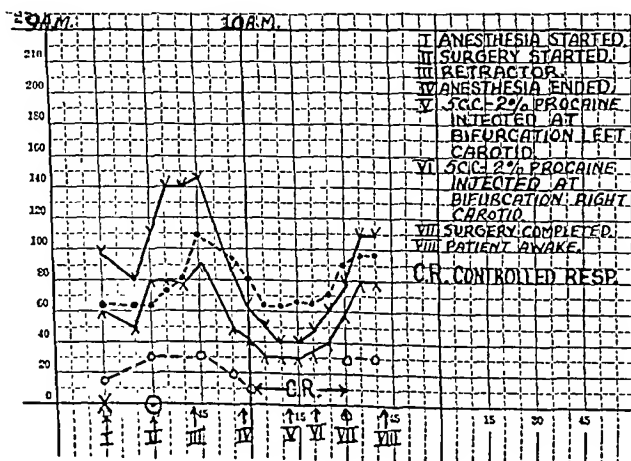


Fig. 3.—During thyroidectomy, the above record of blood pressure determinations, pulse, and respiratory rates was obtained. It will be noted that shortly after a self-retaining retractor was placed (III) and manipulations begun there was a marked fall in blood pressure (solid lines) and decrease in pulse rate (dotted line). Soon (IV) spontaneous respirations ceased (bottom line), and artificial respiration (C.R.) was necessary. Injection of procaine to the left carotid sinus (V) area shown. Injection of similar solution to the right (VI) produced marked effect, as shown.

The usual report of such a fatality includes the information that the death was from circulatory failure immediately after the incision was made. Another group of patients in whom stimulation of the carotid sinus may easily cause hypotension and cardiac inhibition, sometimes extrasystoles, or cardiac fibrillation, include those with thyroid disease. Such individuals are in a state of hyperreflexivity and cardiovascular instability. Anesthesia with the gases or light anesthesia with the volatile agents will further increase abnormal reflexes. With such conditions the dangers of sudden death are not remote.

When an abnormal carotid sinus reflex occurs during operation, it may be recognized by the accompanying circulatory changes. There is a marked bradycardia, a fall in arterial tension, and a diminution of the pulse pressure. The anesthetized patient exhibits signs of syncope; that is, pallor and a cold wet skin. This is a definite indication for immediate treatment. The operation need not be abandoned but should be temporarily discontinued or at least packs and retractors should be removed from the vicinity of the carotid artery. The patient's head should be lowered. Addition of the anesthetic agent should be discontinued and an abundance of oxygen should be given. Stimulating drugs, such as epinephrine or ephedrine, are not indicated nor is intravenous fluid therapy advised. The most urgent and important emergency treatment is injection of 3 to 5 c.c. of a 1 or 2 per cent solution of procaine at the bifurcation of the carotids. The diagnosis, the effects, and the treatment of such reflex reaction are well illustrated by the following case reports.

CASE 2.—A white female, aged 76 years, whose history and physical examination revealed no significant findings, was admitted for resection of tumor in the right anterior triangle of the neck. Premedication was scopolamine hydrobromide 0.0004 gm. given subcutaneously at 1:30 P.M. Anesthesia was induced with cyclopropane at 2:40 P.M., using the closed carbon dioxide absorption technique. An oral endotracheal airway fitted with an inflatable tracheal cuff was placed at 2:50 P.M. Surgery was started at 3:00 P.M. The blood pressure and pulse rate as recorded is shown in the accompanying chart (Fig. 2). It will be noted that traction on the tumor produced a bradycardia and hypotension. Procaine was injected without effect. Further dissection revealed the fact that the injection had not been made near the bifurcation of the carotid. A subsequent injection properly placed was immediately effective in restoring the arterial tension and relieving the bradycardia. Further attempts to elicit the reflex by stimulation after the latter injection were unsuccessful. The patient recovered, with an uneventful convalescence.

CASE 3.—A white female, aged 40 years, was admitted to the hospital suffering from thyrotoxicosis. Thyroidectomy was proposed. Preanesthetic preparation included morphine sulfate 0.015 gm. and scopolamine hydrobromide 0.0004 gm. subcutaneously at 8:00 A.M. Anesthesia was induced, using cyclopropane with the closed carbon dioxide absorption technique at 9:15 A.M. Surgery was started at 9:30 A.M. A record of the blood pressure, pulse, and respiratory rates is shown in Fig. 3.

During the manipulation to excise the gland, the pulse rate slowed suddenly from 110 to 64 beats per minute. Concurrently the blood pressure decreased from 144/90 to a low of 40/30. The patient became extremely pale and respirations ceased. Controlled respirations were instituted, the addition of cyclopropane was discontinued,

ANESTHESIA, ANESTHETIC AGENTS, AND SURGEONS*

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THIS subject concerns itself with the anesthetist, his science and art, in relation to surgery. Cooperation is the essence of such an effort. As the field of knowledge grows, the need for joint endeavor increases.

In the history of anesthesia it will be found that the need for it was recognized long before the agent was discovered. The use of a drug sometimes had to await the discovery of the scientific facts of physiology and pharmacology before the anesthetic agent could be used. Sometimes the physiology and pharmacology at hand presaged the discovery of the agent. Science and anesthesia were necessary for the development of each other, and the art of anesthesia played only a secondary role. The discovery of the circulation of the blood by Harvey was fundamental in developing a knowledge of the function of circulation and respiration. The gaseous exchange between the air and the circulating blood of the lung, with the tissue cells, formed the basis for the use of volatile or gaseous agents in anesthesia. Priestley discovered nitrous oxide in 1772, and Humphrey Davy noted its anesthetic properties in 1799. Henry Hickman and John Snow determined from clinical and experimental evidence the basic knowledge of physiology and pharmacology, and the clinical application had to wait until 1868 when Edmund Andrews used nitrous oxide mixed with oxygen for clinical anesthesia.

As in the historical development of anesthesia, today the same fundamental principles apply. The facts of physiology and pharmacology must be understood and the pertinent scientific knowledge used in the giving of an anesthetic. The action of the drug upon the cell disturbs the normal physiology. A certain concentration tends to reduce reflex irritability and allow surgery. Changes in respiration and circulation, due to the technique of administration and the pharmacology of the drug, will markedly alter the normal physiology of the cells. Varying the dose of the drug, as well as special idiosyncrasies, affects the cell vitally. The volatile or gaseous agent when it gains entrance to the respiratory system brings up the whole subject of physiology, physiologic chemistry, and pharmacology. In order to reduce reflex activity, the cells in different parts of the body must be reached. There is an individual variation, a variation with respect to different tissue, and a general variation. Ordinarily the peritoneal reflexes are abolished in

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SUMMARY

The recent experimental and clinical elaboration of the effects from an abnormal functioning carotid sinus mechanism has aided the anesthetist to a better appreciation of certain physiologic disturbances arising during clinical anesthesia. The different reactions that may be anticipated with different types of abnormal function have been reviewed. The effects upon the carotid sinus mechanism of different drugs used during the preparation of surgical patients are described. It is pointed out that digitalis given preoperatively may be dangerous since it sensitizes the carotid sinus mechanism. Likewise, drugs employed for narcosis, such as the anesthetic gases, certain barbiturates, and avertin, have an added hazard because they exhibit a similar effect upon the reflex. Morphine and ether, when the narcosis is not deep, may elicit a similar response and sudden deaths during anesthesia, in many instances, may be closely related to carotid sinus activity. The dangers from paralyzing the normal reflex mechanism with deep inhalation anesthesia, high spinal block, etc., are also discussed.

A mechanical method for diagnosing the reflex is reviewed and directions for the performance of a diagnostic procaine block are given.

A case report is included to demonstrate the outlined anesthetic management, prophylaxis, and treatment of patients during periarterial sympathectomy of the carotid bifurcation. Additional case reports consider the anesthetic management and emergency treatment of patients exhibiting abnormal carotid sinus reflexivity during operation for other surgical conditions.

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"operator." The art and mechanics of anesthesia follow the basic science and clinical application as naturally as in surgery.

An anesthesia service is of use outside the operating room. The evaluation of the anesthetic risk involved in the patient, the use of depressant drugs for the nonsurgical relief of pain, the employment of anesthesia block to aid in diagnosis as well as in therapy, and the supervision of oxygen therapy all fall within the province of a department of anesthesia. Following the operation, an anesthesia service is of great aid in applying physiology to the problems presented, such as the recognition and proper treatment of shock, whether it is due to trauma, loss of blood, adrenal insufficiency, or sympathetic nerve involvement as is met with in operations on the upper thoracic vertebrae. The early recognition is essential and can be detected by the anesthetist who has important knowledge at hand of the physiologic status of the patient during the operation. Respiratory emergencies which may develop are often suspected during operations. Atelectasis, increased bronchial secretion, and obstructions are met by recognizing the possibilities, and when the emergency arises are taken care of by clearing the airway or using artificial airways or respirators. When the bronchi contain excess of mucus and become clogged, the tracheobronchial tree can be cleared by aspiration. The anesthetist should make postoperative rounds. The type of recovery, the nausea and vomiting, the stabilization of the patient, and the frequency of difficulty in voiding are factors that are important in evaluating the result of an anesthesia. From a critical review of 21,000 cases made by the anesthesia department at the University of Wisconsin, we can see how this applies. In Fig. 1 the percentage of major respiratory morbidity following various anesthetic agents is calculated. In Fig. 2 the same group of cases is analyzed to show respiratory morbidity following various types of operations. It is obvious that the intelligent supervision resulting from a cooperative effort in the care of these patients both during and after operation is more important than the choice of agent. Prevention and correction of the physiologic disturbance are the vital factors.

To assure a cooperative spirit in the surgical team, the surgeon must be in a position to appreciate problems from the anesthetic viewpoint. There must be a harmonious association, with a meeting of the minds and an understanding based on the problems on both sides. Most important is it for the anesthetist to be able to see the patient and study the complete record used in making the diagnosis the day before the operation. The difficulties in the case should be discussed and the plan made for the anesthesia and the operation. The surgeon should appreciate that all the drugs given in the course of the operation are a part of the anesthetic and affect it. Especially is this true regarding opium derivatives. There is a logical basis for this determination. Pain, fever, endocrine imbalance, and the emotions influence the patient so that more

the lower half of the third plane of the third stage. Yet, even in the fourth stage with cessation of respiration, those reflexes may be present so as to make it impossible to close the peritoneum. The use of 0.5 per cent novocain solution injected into the periphery of the rectus sheath has abolished the reflex. With the peritoneum sutured and the anesthesia lightened, a relaxation takes place. This type of reaction does not occur often, but often enough to demonstrate that there is a variation beyond that which can be expected from a tissue or individual variation.

The variations which are controlled by the anesthetist are based on an intimate knowledge of physiology and pharmacology, and the results are determined by the ability to recognize the clinical situation. Chloroform given over a long period of time, or to certain individuals, may result in direct cell damage with a resultant damage to liver function. Carbon dioxide excess causes a change in the biochemistry of the cell. Especially is this true in the red blood cell, for with a high concentration of carbon dioxide there is produced a definite biochemical shift producing an acidosis. To appreciate the biochemical shift, the mechanism of the blood buffers must be known, and the early recognition is necessary for early treatment. While the plasma sodium is around 330 mg. per cent and the plasma potassium 16 to 19 mg. per cent, there is a higher percentage of potassium inside the red blood cell. If carbon dioxide is piled up in the blood, this produces a shift of the chlorine from the plasma to the red blood cell. Since potassium does not diffuse from the cell, the chloride is also retained. This is known as the chloride shift. The biochemistry of the cell is changed. The change in the physical status of the patient modifies the physiology of that patient and the pharmacology of the drug action. Oxygen want has played a small role in the appreciation of anesthesia, and yet it plays an important part in morbidity, causing tissue changes that are hard to evaluate by present means of examination. The physiologists give us a critical level for blood pressure. This is around 50 mm. Hg. If this level is kept for a period of time, cells will suffer from lack of oxygen. This varies with different tissues. Brain cells are damaged more readily than other tissue cells. What the limits are no one knows. That there is a variation in individuals is known, but at present there is no way to determine which patients are susceptible to oxygen want, in the case of ordinary surgical risk.

The technique of anesthesia administration is best safeguarded by a knowledge of pharmacology of the drugs used and by an understanding of the physiologic shifts that may occur in the acid-base balance set up by the body. In surgery, the surgeon learns the fundamentals of the basic sciences, with their clinical applications before the technical side is attempted. Minus this background of basic science and clinical experience, the term used to indicate such an individual would be

fear, pain, and emotional instability. With a metabolic rate of 25 per cent above normal, $\frac{3}{8}$ gr. of morphine will produce no more effect than $\frac{1}{4}$ gr. in a normal person. In an aged person $\frac{1}{6}$ gr. of morphine may be too much. The normal child at 6 to 12 years of age will tolerate more morphine per pound of body weight than at any period of life. A normal infant will tolerate about the same per pound of body weight as a person of 20 years. The surgeon should have enough knowledge

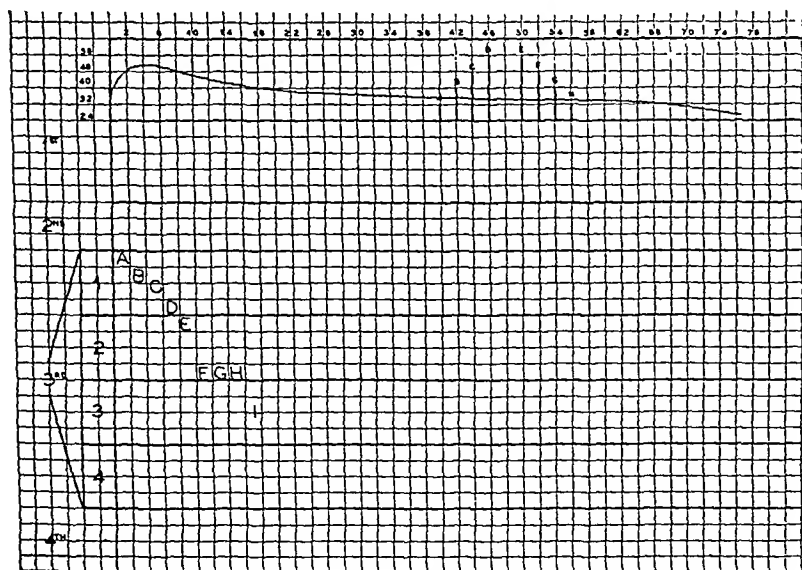


Fig. 3.—With a metabolic rate of 24 calories per sq. mm. of body surface, add the factor of fear and the rate is elevated as indicated by line A; pain will raise it as represented by line B; fever will give line C; and thyroid activity will result in line D. To depress this rate, barbiturates the night before will eliminate fear and give line F; the emotions are allayed and line G results; and preoperative medication with morphine and scopolamine will result in a lower rate—a much easier patient to handle. Levels of anesthesia at which reflexes are abolished: A, First part of first plane, third stage. Brain, bone, thyroid, breast, stomach, kidney, and other glandular tissues, except for traction reflexes from their coverings or attachments, are abolished. B, Upper half of first plane, third stage. Skin reflexes are usually abolished at this level. C, Below middle of first plane, third stage. Pharyngeal reflex is abolished. D, Lower border of first plane, third stage, abolishes or renders negligible reflexes caused by injury to or cutting great sciatic nerve. E, Junction of first and second planes, third stage, abolishes cough reflex. F, G, and H, Lower level of second plane, third stage, abolishes or renders negligible muscle reflexes. The anal sphincter reflex may not be abolished by the fourth stage. The traction reflexes met with so frequently in abdominal surgery may be abolished but readily instituted by rough handling of the viscera. The subdiaphragmatic reflex, an adduction of the vocal cords usually upon expiration with a contraction of the abdominal muscles, may be present in the third plane; then intubation is preferable to deeper anesthesia. I, Third plane, third stage, abolishes tone of smooth muscle when it reaches the middle of the plane (Guedel). (From Waters and Schmidt: *Anesthesia and Surgery*, Ann. Surg. 106: 790, 1937.)

of anesthesia to appreciate the applicability of different drugs and different dosages to particular operative requirements as they appear. If the reflex irritability is not reduced enough to carry out a certain procedure, he should wait until the proper depth of anesthesia has been reached. (Fig. 3.)

Preoperative hypodermic medication with some sedative drugs usually takes one to two hours to act. Properly timed, it will greatly aid the anesthetist; but, if the schedule is upset and only fifteen minutes is

of the anesthetic agent is required. The opium derivatives depress metabolism directly because they allay pain, inhibit mucous secretion, and aid the actions of the soporific drugs when given in combination with them. Barbiturates are not analgesic. In heavy doses they depress respiration specifically. However, in moderate doses they depress metabolism due to decreased emotional excitability. The dose of opium derivatives may be increased per pound of body weight in direct proportion to the increased metabolic rate of the patient when due to fever,

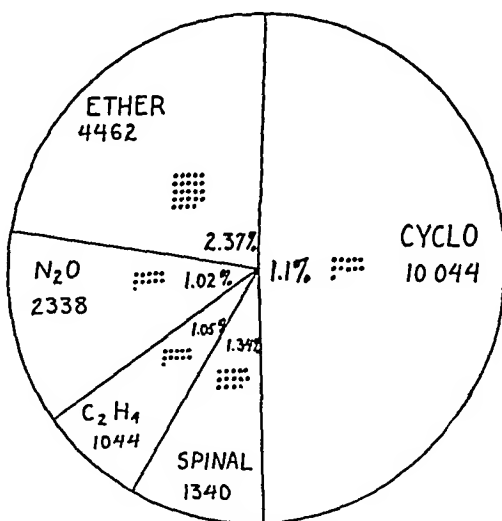


Fig. 1.—Major postoperative respiratory complications, by anesthetic agents.

10,282 CASES

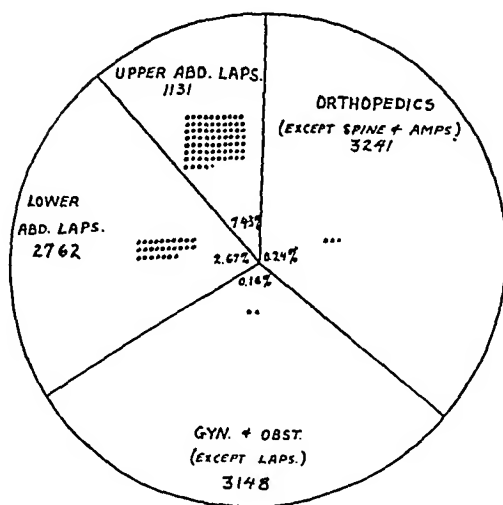


Fig. 2.—Major postoperative respiratory complications after certain types of operations.

A MASSIVE ADENOMATOUS GOITER SUCCESSFULLY REMOVED

CASE REPORT

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THERE are several reports in the literature concerning massive enlargements of the thyroid. In 1817, Alibert published illustrations of huge goiters extending downward as far as the waist. Although he does not show drawings, he alludes to an almost incredible case in which the cervical mass was cylindrical and reached to the middle of the thigh.

In older days, the thyroid had to be of enormous proportions before surgical removal was attempted. The mortality of such procedures was high, due to hemorrhage and sepsis. Dupuytren's first thyroidectomy was admirably performed, but the outcome was tragic. He removed a goiter from a 28-year-old woman which was "oblong, nodular, with a volume as great as that of the lungs of a young child." It weighed 1,202 gm., or 2 pounds, 8 ounces. Although the gland was removed in a relatively bloodless manner (all vessels were doubly ligated before division), the patient died from "shock" thirty-five hours after operation. It was eleven years before Dupuytren ventured to do a second thyroidectomy. This time, the patient, a girl 12 years of age, had a tumor "the size of her head occupying the whole left side of the neck." At operation this goiter was found to have a broad base. Hemorrhage from many veins was inadequately controlled by finger pressure. The patient was in syncope at the end of the operation and died forty hours later.

Bach, in 1841, removed a goiter which was 10 cm. in all diameters. A few years later Ballard reported the successful extirpation of a "voluminous" goiter from a 19-year-old girl. Sédillot also records several instances in which he removed "enormous thyroid tumors." In one case the tumor was the size of an infant's head and hung over the chest.

Péan, in 1878, enucleated a "solid goiter" (adenoma) of the right lobe, the size of a fetus' head. The vessels were clamped before division, thirty-five clamps being used. Twelve of these clamps were removed the following day. Unfortunately the patient died about two weeks later with signs of mediastinal abscess, pericardial and pleural effusion. Halsted remarks that the number of clamps still remaining in the wound at the time of death was not mentioned.

permitted for action of preoperative medication, the whole plan of anesthesia has to be altered. Even when using what the anesthetists call a 100 per cent agent is this true.

To reach a proper concentration of the anesthetic agent in the blood stream needs a certain amount of time which will vary with individual cases and agents, depending on a number of factors, such as a non-obstructed airway, circulatory activity, the amount of pain the patient's pathology gives him, the amount of fever present, the emotional disturbance present, and possible endocrine imbalance.

Sudden changes in the operation may jeopardize the anesthetist's success. When doing a laparotomy and working inside the abdomen with packs all placed, the depth of anesthesia may be in the second plane of the third stage. A sudden quick pull on a retractor, by an assistant who has just awakened, immediately irritates the deep muscle reflexes, the abdomen becomes tight, the packs are displaced, and the entire operative field is disturbed. The depth of anesthesia has to be deepened. This takes time, prolongs the operation, and helps in producing shock. Why carry the patient so light? Because twenty minutes in the lower half of the third plane in the third stage is equivalent to two hours in the second plane of the third stage. Third plane (lower half) tends to paralyze smooth muscle and produces shock.

The surgeon should never force the decision as to the type of anesthetic agent used or how it is given. This should be left entirely to the anesthetist. The problem should be discussed and the surgeon should let the anesthetist know what is necessary in order to perform the operation. The anesthetist knows his ability and his limitations. He knows best how to give the surgeon the anesthesia the surgeon desires and what the patient can safely stand. The surgeon would resent being told he had to do an operation in a certain way if he knew that in some other way his knowledge and skill could be applied to give the patient a better result with less risk.

Anesthesia and surgery are bedfellows. Anesthesia has advanced remarkably in the last twenty years. Surgeons are still using anesthesia on the old empirical basis. In order to get the best anesthesia has to offer, there must be a realization on the part of the surgeon of the advances made and the possibilities that it offers. This field of surgery has become broad, just as other fields in medicine. It is not limited to the art alone, nor to the operating room. Therefore the utilization of this new field, as in other fields, means the cooperation of the internist, the anesthetist, and the surgeon.

small goiters are now safely removed is probably one of the reasons why large goiters rarely are seen today.

The weight of the normal adult thyroid gland in Minnesota is about 30 gm., the variability being 10 to 50 gm. (Rice). In this region very large goiters are rarely seen; in fact, at this clinic the incidence of goiter seems to be decreasing. From January, 1928, to January, 1933, 782 instances of enlargement of the thyroid were seen; while from January, 1933, to January, 1938, only 659 cases were observed (about 16 per cent decrease). The explanation for this decrease is not apparent.

The following case is reported not only because it is one of the largest goiters ever seen at this clinic, but also because certain surgical procedures facilitated its removal.

CASE REPORT.—Mrs. A. M. (Hospital No. 666713), aged 38 years, was admitted to the University of Minnesota Hospitals on March 22, 1938, and discharged April 6, 1938.

The patient said that she had noticed a progressive enlargement of the thyroid for the past eighteen years. Eight and two years ago, respectively, there were sudden increases in the size of the goiter following childbirth. She thought that the mass in the neck was larger at the time of her menses. For the past two years, the patient noticed slight hoarseness, dyspnea on exertion, orthopnea, and weakness in the lower extremities on climbing stairs. There had been a gradual increase in body weight for eighteen years.

Past History: The patient had had measles and mumps as a child. Occasionally she suffered from headaches. Gastrointestinal and genitourinary histories were essentially negative. Menstrual history was negative except that lately she menstruated every twenty days instead of every twenty-eight, and the flow was somewhat increased.

Family History: The patient was married and was the mother of four girls. None of the girls had enlargement of the thyroid. The mother and one sister of the patient had goiters which were not as large as that of the patient.

Physical examination revealed a very obese, intelligent, white female with a massively enlarged goiter. She weighed 220 pounds and was 68¾ inches tall. Her temperature was 98.6°, pulse 84 beats per minute, and the respirations 18 per minute.

Head: Essentially negative. There were no eye signs characteristic of hyperthyroidism.

Neck: The thyroid was massive and diffusely enlarged (Fig. 1). The greatest circumference of the neck was 54 cm.; the circumference just below the chin was 49 cm. The goiter was nodular and firm; there were no tender or fluctuant areas. It was not fixed to the skin or deeper structures, but was so enormous that it was immobile on swallowing. No bruit was heard or thrill felt over the gland. The neck vessels were very prominent.

No abnormalities were found in the heart and lungs. Blood pressure was 130/80. Examination of the abdomen, extremities, pelvis, and rectum was negative.

Laboratory Data: Examination of the blood and urine was essentially negative. Wassermann reaction was negative. The patient belonged to Group II blood group. Electrocardiographic tracings were normal. Orthodiagram revealed the ratio of the transverse diameter of the heart to that of the chest to be 58 per cent. Basal metabolism test on March 4, 1938, was -1 per cent and on March 28, -8 per cent.

X-rays revealed a large mass in the suprasternal region extending out on both sides. The esophagus in the posterior-anterior view was pushed to some extent to

Porta operated upon a man 38 years of age who was suffocating from a very large goiter. Venesection was tried without relief and then ligation of what was thought to be the enlarged inferior thyroid artery. At autopsy it was noted that the ligature had been placed on the internal carotid artery.

Bottini between the years 1878 and 1883 successfully removed several "parenchymatous goiters" varying in size from that of a "melon to an infant's head." He is said to have been the first Italian surgeon to perform a total extirpation of the thyroid and the first in Italy to employ listerism in operations on goiter.

Perassi reported the case of an enormous goiter, "a broncholipo-cele," which hung over the breasts down to the abdomen of the patient. Berruti, Ruggi, and Medini also successfully treated large goiters. In Medini's case, the tumor was incised and 900 gm. of colloidal substance evacuated.

Liston, in 1840, reported a large bronchocele on the left side of the neck which he treated by dividing the sternomastoid muscle to relieve pressure. Halsted says that Liston, at that time England's most dexterous operator, was helpless when confronted with a goiter. About thirty years later Holmes removed an enormous cyst of the thyroid which hung below the patient's waist. In spite of a skillfully performed operation, the patient died of hemorrhage and erysipelas. A few years later Stoker attempted to excise a goiter equally as large as that removed by Holmes. The operation was performed in two stages, but the patient died from sepsis and thrombosis of the pulmonary artery on the fifth postoperative day.

In this country, Harris, W. W. Greene, Marshall, Maury, and Berry have reported instances of enormous thyroid enlargements. In 1860, Knobe reported the case of a degenerated bronchocele into which he "plunged a bistoury and withdrew a gallon and three pints of inodorious and insipid fluid." Berry extirpated the right and middle lobes of a goiter in a woman 52 years of age. The removed tumor weighed 3 pounds, 1 ounce. A. J. Ochsner has reported the case of one of the largest thyroids successfully removed, the excised gland weighing 3,584 gm., "after the blood had been drained out of it." The largest goiters removed by Kocher, Billroth, Halsted, Lahey, or Crile are not ascertained from a review of the available literature. In 1916, C. H. Mayo removed an adenomatous goiter weighing 1,554 gm. (Pemberton).

With the advent of asepsis, anesthesia, better operative technique, and a knowledge of the physiology of the thyroid gland, removal of the diseased thyroid changed from an operation of necessity to one of election. It is said that approximately 5,000 operations on the thyroid were performed in Kocher's clinic up to the time of his death in 1917. The mortality in the later cases was a fraction of 1 per cent. The fact that

Laryngoscopic examination revealed the left vocal cord to move normally; the right cord was not visualized.

The preoperative diagnosis was a large adenomatous goiter without hyperthyroidism. On March 29, 1938, the patient was operated upon (Dr. Owen H

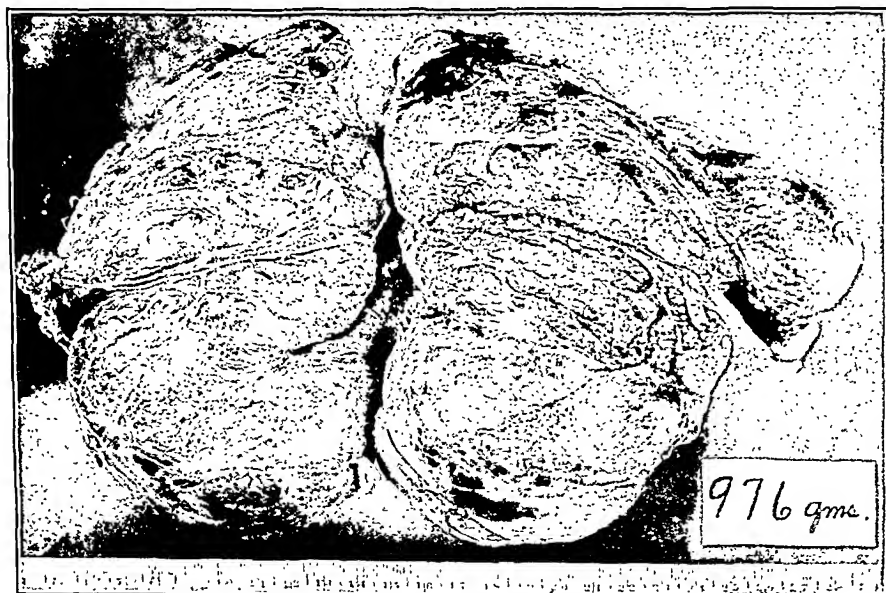


Fig. 3.—Mrs. A. M. Goiter; specimen at operation.



Fig. 4.—Mrs. A. M. Goiter. Appearance of patient after operation. A, lateral view; B, anterior view.

the right. In the lateral view a large soft tissue mass was seen to extend anteriorly. The trachea did not appear to be compressed to any great extent. An esophagram with barium showed the esophagus and larynx to be pushed or pulled anteriorly away from the vertebrae by the soft tissue mass (Fig. 2).

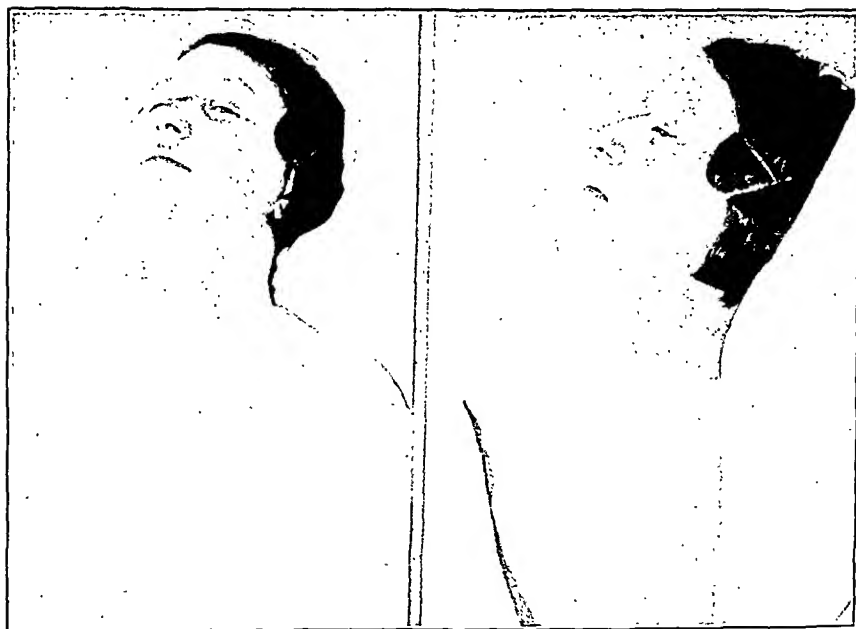


Fig. 1.—Mrs. A. M. Goiter, before operation. A, Anterior view; B, lateral view.



Fig. 2.—Mrs. A. M. Goiter. X-rays of neck; esophagram (note displacement of trachea).

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(Wangensteen). Because of the possibility that the trachea had been compressed, intratracheal anesthesia with cyclopropane was used. Also, because of the probable vascularity of the tumor and the danger of shock from loss of blood, the patient was given 600 c.c. of citrated blood during the operation. A rather long transverse incision was made over the neck. The anterior jugular veins were clamped, cut, and tied with fine silk. The strap muscles which were thinned from stretching, and the fascia of the neck also were cut transversely. By means of a Kocher dissector, a line of cleavage was defined between the trachea and the thyroid. Before dividing the isthmus, a double linen suture was tied tightly around the gland on each side of the midline to control any bleeding. The isthmus was then incised between the sutures. By means of lateral retraction with a cat's-paw retractor, the right and left lobes of the thyroid could be lifted forward into the operative field. A bilateral subtotal thyroid resection was then done, leaving the posterior capsule well intact. Bleeding points were clamped and tied with fine silk. There was surprisingly little blood loss considering the size of the goiter. The tracheal rings did not seem to have been weakened by compression from the goiter. The residual thyroid tissue on either side was coaptated by interrupted silk sutures. Interrupted sutures of fine silk also were used to unite the divided muscles and fascia and Michel clips were used to approximate the skin edges.

The right lobe weighed 400 gm. and the left 576 gm. The gross and microscopic appearance was that of an adenomatous goiter with numerous cystic areas containing colloid (Fig. 3).

The patient's convalescence was uneventful. The postoperative treatment consisted of steam inhalations and sedatives. She was not given Lugol's solution postoperatively; it should be mentioned that three weeks before operation she had taken ten drops of Lugol's solution, three times a day, for a ten-day period. Laryngoscopic examination on April 2, 1938, revealed normal mobility of the vocal cords. The wound healed by first intention. The patient was discharged April 6, 1938, with instructions to return in two months for check-up. (Fig. 4.) The patient was seen on June 15, 1938, at which time the neck wound was well healed. Basal metabolism rate at that time was +2 per cent. The patient felt well and offered no complaints. Recently her local doctor wrote that she has remained in good health.

SUMMARY

A massive adenomatous goiter weighing 976 gm. successfully removed by operation is described.

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CARCINOMA OF THE PARATHYROID GLAND

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INTRODUCTION

SINCE the demonstration by Mandl^{1, 2} that the removal of a parathyroid adenoma improved the condition of a patient suffering from von Recklinghausen's diffuse fibrocystic disease of the bone, much attention has been given to the parathyroids and their newgrowths. Benign parathyroid adenomas have been reported by numerous investigators. Castleman and Mallory³ in 1935 collected 160 cases from the literature and to that number added 25 cases of their own.

Of less frequent occurrence is carcinoma of the parathyroid gland. Hall and Chaffin⁴ in 1934 summarized 18 cases of malignant tumors of the parathyroid, including 1 of their own. Since then single cases have been reported by Petersma,⁵ Snell,⁶ and Armstrong.⁷ In only a few cases was the nature of the disease recognized before surgery was done and the nature of the tumor recognized by histologic study. Because of that, a blood chemistry workup, which is so essential in establishing the diagnosis of a parathyroid newgrowth, was not done until some time after the operation. The report of this case perhaps may be of greater value since a more complete blood chemistry analysis was made before the removal of the parathyroid gland and was continued for fourteen months following operation.

REPORT OF A CASE

J. H., a 56-year-old white Greek male, was admitted to the Cook County Hospital on Oct. 8, 1937. With the aid of an interpreter, the following history was obtained. The patient stated that he had been perfectly well until April, 1937, when he first noticed the gradual appearance of a slightly painful swelling of the proximal portion of the right little finger. The pain was of a dull aching character, but it was not constant and was relieved considerably by resting the finger, which was gradually increasing in size.

On May 6, 1937, the patient tripped on a curb and fell on his left elbow, fracturing his left humerus. He was hospitalized and traction was applied for fourteen days. A plaster cast was then applied for four weeks and was followed by good anatomic and functional results.

On June 7, 1937, the patient fell from a street car, injuring his right arm and shoulder, but he did not sustain any fractures. Ten days following this last accident the pain in the little finger became more intense and radiated to the right wrist and the right shoulder, where it remained more or less constant. In August, 1937, the patient noticed a swelling of the right wrist and this he failed to reduce with

epsom salt compresses. He stated that since April, 1937, he had lost 40 pounds in weight. Other than these complaints the patient was troubled only with constipation and never complained of any urinary or stomach difficulties. Ten years prior to admission to the hospital he was operated upon for a hernia and twenty-eight years before admission he had suffered from a gonorrheal urethritis.

On examination the patient was quite emaciated but not acutely ill. His temperature was 98° F.; pulse, 84; respirations, 20; blood pressure, 120 systolic and 70 diastolic. The frontal bosses were prominent. The eyes showed an arcus senilis. The pupils were round and equal and reacted to light and accommodation. The tonsils were atrophic.

On palpation of the neck, a firm tumor about the size of a large walnut was felt to the right of the trachea and just above the sternoclavicular joint. It moved upward on swallowing and did not seem to be adherent to the surrounding tissue.

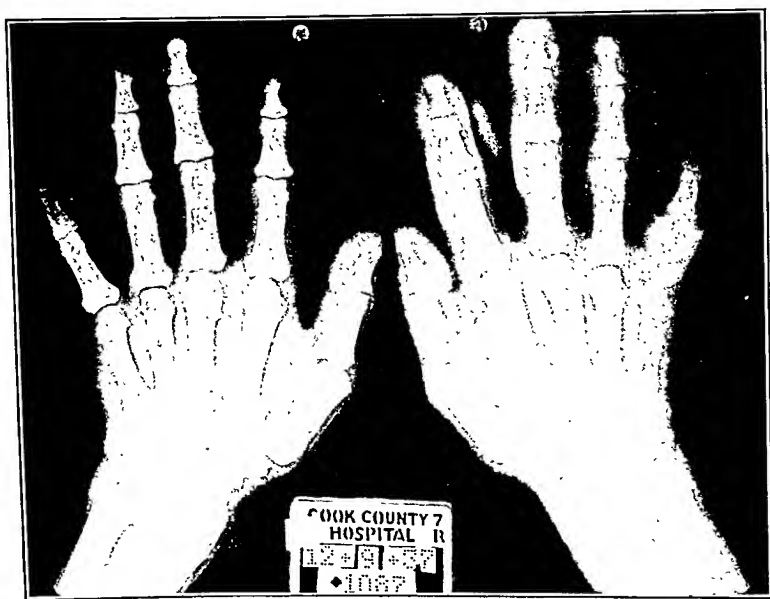


Fig. 1.—X-ray picture of both hands, showing the marked fibrocystic changes of the metacarpals and the phalanges, particularly the proximal phalanx of the right fifth finger and also the right ulna. This picture was taken about six weeks after surgery was done.

The chest revealed a lower thoracic scoliosis and kyphosis. The lungs were resonant throughout. No râles were heard. The apex beat of the heart was neither visible nor palpable. The heart tones were distant, and no murmurs were heard. The liver, kidneys, and spleen were not palpated, nor were any masses felt in the abdomen.

The extremities revealed some interesting findings. There was a fusiform enlargement of the fifth digit of the right hand associated with tenderness on pressure. The distal portion of the right ulna, over an area of about 2½ inches, was swollen and tender, as were both tibia on their anterior surfaces. Both clavicles showed a fusiform swelling at the junction of the outer and middle thirds. These fusiform swellings felt rather soft and gave one the impression of fluid's being present. However, no crepitus was elicited.

In view of the above findings, a clinical diagnosis of von Recklinghausen's generalized osteitis fibrosa cystica due to a parathyroid adenoma was made.

In order to substantiate this diagnosis, the following laboratory work was carried out preoperatively. Blood chemistry examination revealed a serum calcium of 15.9 mg. per 100 c.c.; the blood phosphorus, 3.1 mg. per 100 c.c. of blood; the blood phosphatase, 22 Bodansky units; the blood urea, 21; and the blood sugar, 75 mg. per 100 c.c.

The red blood cell count was 4,370,000; the hemoglobin, 82 per cent; the white blood cell count, 8,500, with 76 per cent neutrophilic polymorphonuclear leucocytes, 1 per cent eosinophiles, 2 per cent basophiles, 18 per cent lymphocytes, and 3 per cent monocytes.

The urine examination revealed a few white blood cells and epithelial cells. A Mosenthal test revealed a reduced, fixed, specific gravity varying between 1.008 and 1.012.

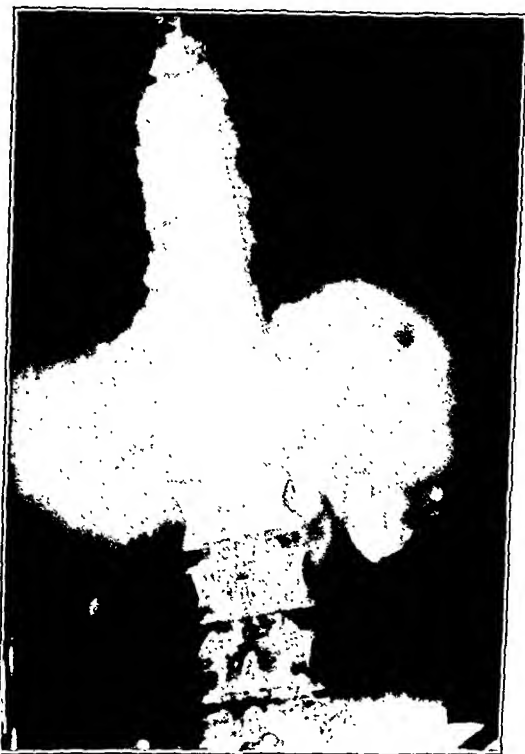


Fig. 2.—Flat plate of the abdomen showing calcified areas in the region of the kidneys.

A quantitative phenolsulphonephthalein test revealed a 20 per cent output at the end of the first hour and a 40 per cent output of the dye at the end of two hours and 10 minutes.

X-ray examination of the skull, clavicles, humeri, tibia, ribs, and hands showed multiple bone lesions characteristic of generalized osteitis fibrosa cystica. These changes were particularly marked in the proximal phalanx of the right fifth finger, as well as in the metacarpals and phalanges (Fig. 1). A flat plate of the abdomen revealed dense shadows in the renal areas which were very suggestive of kidney stones (Fig. 2).

In view of the above findings, surgery was advised for alleviation of symptoms. On Oct. 28, 1937, the patient was operated upon by one of us (K.A.M.) and a parathyroid tumor in the right side of the neck was removed.

PATHOLOGY REPORT

The specimen consisted of a moderately encapsulated piece of tissue measuring 6 by 5 by 4.5 cm. (Fig. 3). On sectioning, the cut surface was light tannish gray traversed by grayish white bands. In one area close to the surface of the tumor were several cystlike areas ranging to 15 mm. in diameter and filled with a liquid brownish gray material and clotted blood.

A quick frozen section was made from one portion of the node and it revealed a nonhornifying squamous cell carcinoma. (The sections of this tumor were also seen by the late Dr. R. H. Jaffe, who concurred in this diagnosis.) Sections were later taken from the entire cross section of the tumor and studied with various stains; namely, hemalum-eosin, Best's carmine stain for glycogen, Heidenhain's azocarmine stain, Mallory's phosphotungstic acid hematoxylin, and van Gieson's stains. The

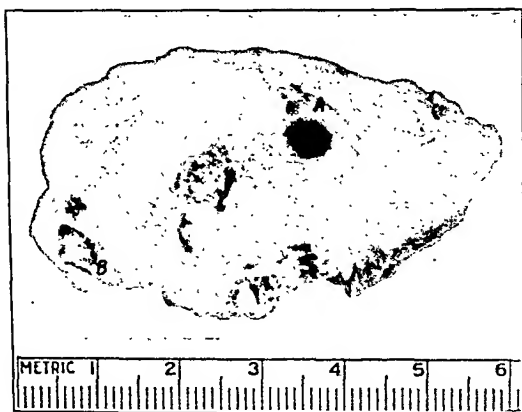


Fig. 3.—Sectioned surface of the carcinoma of the parathyroid gland, showing focal areas of hemorrhage (A) and wall of the surface cyst (B).

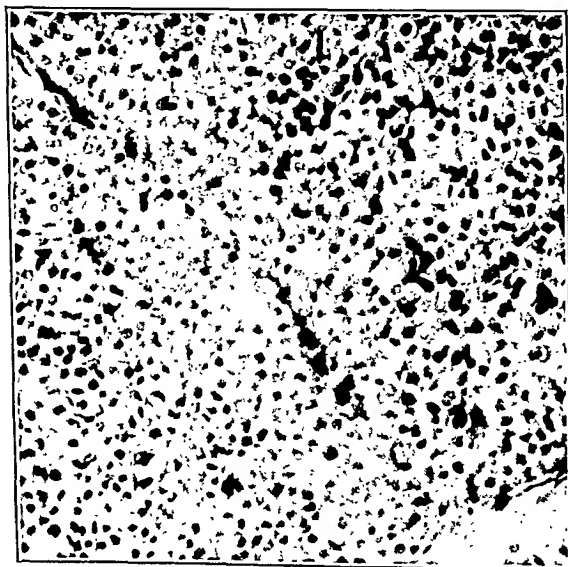


Fig. 4.—Section through the center of the tumor mass, showing characteristic water clear cells arranged in solid nests and cords. (Hemalum-eosin stain, $\times 276$.)

central portion of the tumor mass was occupied by parathyroid tissue, composed of solid cords of "water-clear" cells and of transitional cells separated by a clear stroma (Fig. 4). In places these water-clear cells reached considerable size.

Towards the periphery of the tumor mass, the picture changed, and here one saw a more abundant stroma associated with the absence of the water-clear cells. The



Fig. 5.—A, Showing transitional changes of the water-clear cells to polygonal cells containing larger and slightly irregular nuclei (hemalum-eosin stain, $\times 276$). B, Showing changes of transitional cells to squamous cells containing darker stained elongated and irregular nuclei (hemalum-eosin stain, $\times 560$). C, Section showing a mitotic figure with plump chromosomes (hemalum-eosin stain, $\times 560$).

transitional cells showed an increase in size and a gradual change of shape (Fig. 5A). They were arranged in forms of anastomosing cords and alveoli, which extended through a thin capsule into the surrounding fat tissue. The changes in shape caused the cells to resemble squamous epithelial cells, and in one alveolus one could see the various transitions from the large hypertrophic transitional cell to the polygonal squamous cell with deeply stained and slightly irregular nuclei (Fig. 5B).

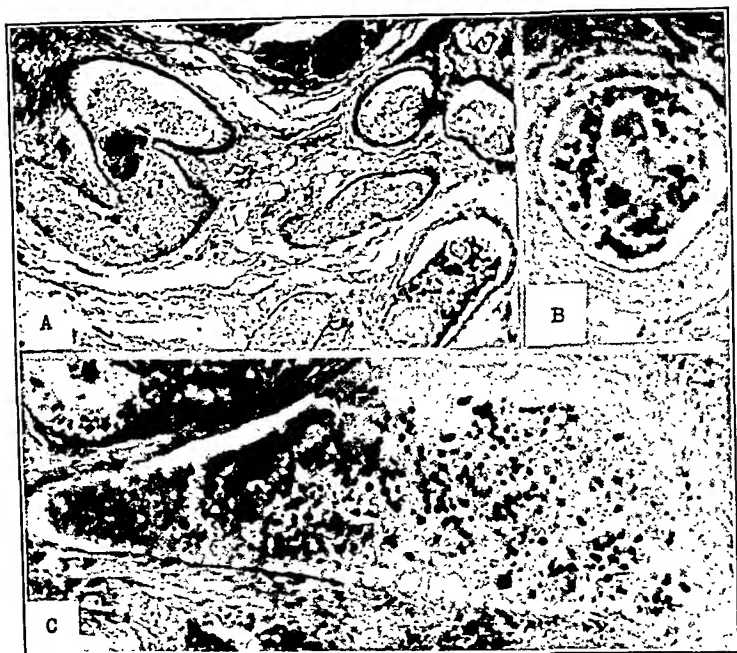


Fig. 6.—*A*, Section of the capsule of the parathyroid tumor showing tumor thrombi in the lumina of the dilated veins ($\times 100$). *B*, Tumor thrombus in a blood vessel in capsule of parathyroid tumor ($\times 280$). *C*, Tumor cells in a lymph vessel in tumor mass proper ($\times 280$).



Fig. 7.—Biopsy section taken from the proximal phalanx of the right fifth finger showing the characteristic picture of a benign giant cell tumor of bone (hemalum-eosin stain, $\times 70$).

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During the first fourteen days after surgery, the patient was placed on calcium lactate 30 gr. t.i.d., and for six weeks following he was placed on calcium lactate 10 gr. b.i.d.

The course of the serum calcium and blood phosphorus levels are shown in Table I.

TABLE I

DATE	SERUM CALCIUM NORMAL: 9 TO 11 MG./100 C.C.	SERUM PHOSPHORUS NORMAL: 3.7 TO 5 MG./100 C.C.	PHOS- PHATASE BODAN- SKY UNITS	CALCIUM LACTATE	VARIA
10/21/37 Preoperative	16.1 mg./100 c.c.	3.1 mg./100 c.c.	22	.	Urea nitro- gen, 21 mg. Blood sugar, 75 mg.
10/26/27	15.5 mg./100 c.c.	3.0 mg./100 c.c.			
Postoperative 10/29/37	10.1 mg./100 c.c.			30 gr. t.i.d.	
11/11/37	8.0 mg./100 c.c.				
11/18/37	9.1 mg./100 c.c.				
11/22/37	9.1 mg./100 c.c.	3.0 mg./100 c.c.		10 gr. b.i.d.	
11/27/37	9.1 mg./100 c.c.				
12/ 8/37	9.0 mg./100 c.c.	2.4 mg./100 c.c.		Discon- tinued	
6/ 8/38	12.9 mg./100 c.c.	1.99 mg./100 c.c.			
8/11/38	12.86 mg./100 c.c.	1.45 mg./100 c.c.	7.55		Pains return
11/18/38	15.05 mg./100 c.c.	2.05 mg./100 c.c.	7.87		Nonprotein nitrogen, 32 mg.
1/ 5/39	14.65 mg./100 c.c.	2.38 mg./100 c.c.	9.74		Total pro- tein, 7.9%

The patient was heard from at intervals and about March, 1938, he began to complain of recurring pain, particularly in the right hand. On July 9, 1938, he returned to the hospital with the intention of having his right little finger amputated since it had grown larger in size and interfered with his work. During his last stay in the hospital, we were able to radiograph his entire skeletal system and, despite the raised serum calcium and reduced blood phosphorus and slight increase in the blood phosphatase content, the bones showed a marked improvement with large areas of recalcification. This was particularly marked in the right radius (Fig. 8), ribs, and both tibia. These changes were not evident shortly after removal of the parathyroid tumor.

A further physical examination at the patient's last admission revealed a hard nodule about 3 cm. in diameter in the region of the right lobe of the thyroid gland.

On Aug. 13, 1938, the right fifth finger was amputated at the metacarpal phalangeal joint. On examination the entire proximal phalanx was transformed into a globoid swelling 3.5 by 2 by 3 cm., which on sectioning was soft and dark purplish red in color. The cortex of the bone was completely destroyed in places; whereas, in other places a thin shell was still discernible. The palmar structure of the finger in that area was pushed anteriorly but not invaded by the tumor tissue.

A microscopic examination at this time revealed a picture similar to that described in the biopsy of the same finger (Fig. 6).

DISCUSSION

In view of the fact that carcinomas of the parathyroid gland are usually diagnosed only after the microscopic examination of the tissue is

In focal areas mitotic figures were seen which were irregular and showed sharp, plump chromosomes (Fig. 5 C).

In the lumen of the blood vessels found in the intact capsule of the tumor mass were large tumor thrombi (Fig. 6 A, B) which partially occluded the lumen of the blood vessels. Similar tumor thrombi were found in the lymphatic vessels (Fig. 6 C).

A biopsy made from the swelling of the proximal phalanx of the right little finger revealed a giant cell tumor of osteoclast type which was embedded in plump, spindle-shaped cells (Fig. 7). Throughout the section there were numerous histiocytes laden with iron pigment.

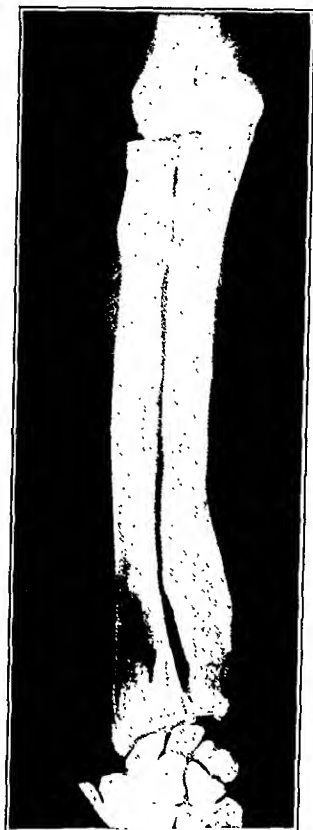


Fig. 8.—X-ray picture of the right ulna, showing marked calcification of the previously existing fibrocystic changes about eleven months after surgical removal of the parathyroid gland.

In view of the above findings, the diagnosis reached was that of a nonhornifying squamous cell carcinoma of the parathyroid gland, associated with a disseminated fibrocystic disease of the bone (von Recklinghausen's).

We have been fortunate in being able to observe the course of the patient for the past fourteen months, and at various intervals have studied his blood calcium and phosphorus and on three occasions the blood phosphatase. The patient made a rapid postoperative recovery and at no time did he develop any signs or symptoms of tetany. Three weeks after the operation, he stated that the pains in his bones had diminished and that he felt rather well.

may in itself not be sufficiently high to strongly suggest disease, one can still be led to the right diagnosis if the blood phosphorus is persistently low. They emphasized, too, the relationship between the total serum proteins to the serum calcium, the latter usually being low when the total serum protein is low. It may be mentioned here that Albright, Sulkowitch, and Bloomberg are of the opinion that the parathyroid hormone acts more directly on the calcium and phosphorus equilibrium in the body fluids. When there is an increased loss of calcium and phosphorus in the urine and feces, the predisposition of bone changes makes itself apparent but does not necessitate its occurrence. They supported their contention by the fact that not infrequently hyperparathyroidism may exist without bone changes, as shown in their work and the work of other authors who have reported parathyroid adenomas. Of the carcinomas of the parathyroid gland reported in the literature, Chaffin and Hall in their review of eighteen cases showed only one case with bone changes. Since then Snell⁶ has shown milinary osteoporosis and renal calculi in his case. Armstrong⁷ in his case failed to note any bone changes.

In our case we definitely dealt with a carcinoma of the parathyroid gland which, from the clinical picture, showed definite signs of hyperparathyroidism; namely, disseminated fibrocystic disease of the bone, renal calculi, a high serum calcium, a low blood phosphorus, and a high phosphatase content in the blood. Following the surgical removal of the tumor, the patient showed marked improvement, as indicated by the x-ray findings in the bones, although recent blood chemistry findings indicated the persistence of parathyroid hyperactivity. Still more recently, recurrent decalcified areas have been noted in some of the long bones.

SUMMARY

A case of carcinoma of the parathyroid gland is discussed, showing typical symptoms of hyperparathyroidism. The removal of the tumor aided in the alleviation of the subjective symptom, pain in the joints. X-ray of the bones showed a definite recalcification of the fibrocystic areas, followed later by a decalcification of some of the long bones. However, the blood findings, namely, a high serum calcium, a low blood phosphorus, and a slightly increased phosphatase, showed a persistent hyperparathyroidism.

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made, the effect of carcinoma of the parathyroid gland and its relation to the serum calcium and blood phosphorus content unfortunately were not studied. In the eighteen cases reviewed by Hall and Chaffin,⁴ only one case had a calcium and phosphorus determination prior to surgery. Petersma⁵ demonstrated a fall in serum calcium following a removal of a "malignant adenoma" of the parathyroid gland, in which he found tumor cells in the lumen of the blood vessels. Snell⁶ likewise demonstrated high serum calcium and blood phosphorus which returned to normal levels following removal of the tumor. In Armstrong's case there was no appreciable rise in the serum calcium or fall in the blood phosphorus preoperatively. In our case there was a definite fall in the blood calcium in the early postoperative period (chart). Ten months later a distinct rise in the serum calcium was noted, the blood phosphorus was below its normal level, while the blood phosphatase was slightly increased.

Although Jaffe⁸ and Herxheimer⁹ claimed that there is some doubt as to the possibility of a carcinoma existing in the parathyroid gland and criticized some of the cases reported as such, one cannot ignore the cases reported by Sainton and Millot,¹⁰ Petersma,⁵ and Guy.¹¹ Sainton and Millot were able to follow their case over a period of years after the first removal of a benign adenoma of the parathyroid gland in a case of von Recklinghausen's disease of the bone. Following the first operation, the patient failed to improve physically. The serum calcium remained constantly above normal, and x-ray therapy failed to improve the general bone condition of the patient. At the second operation two years later, they succeeded in removing a parathyroid tumor which histologically showed definite evidence of malignancy in places, as characterized by the invasion of tumor cells into the surrounding capsule.

Guy¹¹ in his paper, also demonstrated tumor cells in the blood vessels of the parathyroid tumor he described. He reported a recurrence of this tumor one year later, and this was proved by biopsy examination. A disconcerting feature in his case was that the serum calcium was only 8 mg./100 c.c., despite the recurrence of the tumor.

Hall and Chaffin⁴ also demonstrated metastases to blood vessels, but here, too, the serum calcium and blood phosphorus were within normal limits postoperatively.

It is obvious, therefore, that in the properly observed cases of true carcinoma of the parathyroid gland there exists a definite change in the calcium-phosphorus ratio as well as an elevation of calcium and frequently a lowering of the blood phosphorus.

Although Albright, Sulkowitch, and Bloomberg¹² emphasized that frequently in benign parathyroid adenomas the serum calcium level

SURGICAL EXPLORATION AND CLOSURE OF A PATENT DUCTUS ARTERIOSUS

REPORT OF SECOND SUCCESSFUL CASE

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IT IS commonly recognized that a congenital abnormality of the heart is potentially serious, not only because of the mechanical embarrassment from the defect itself, but also because of the possibility of a superimposed subacute bacterial endocarditis. The incidence of this secondary infection varies somewhat with the different types of malformations. Available statistics¹ indicate that this complication occurs in 25 to 30 per cent of patients who have a persistent patency of the ductus arteriosus unassociated with other cardiac anomaly. A second danger, not so rapidly fatal but nevertheless a grave complication, is found in 40 to 50 per cent of individuals with an otherwise uncomplicated patency of the ductus. This takes the form of cardiac decompensation, resulting from the long-continued burden on the heart by a shunt which is essentially an arteriovenous communication.

The presence of a patent ductus Botalli in a person who has reached late childhood or early adolescence at once places the possessor in a precarious position because of possible complications which might supervene. While statistics on the subject are difficult to obtain and are hard to apply to an individual case, it would summarize the findings to date to say that a child with a patent ductus has approximately one chance in four that he will live an essentially normal length of life, has about one chance in four that he will die of *Streptococcus viridans* infection of the pulmonary artery or endocardium, and almost two chances in four that he will die of cardiac decompensation. Such a prognosis does not mean that the child will not enjoy many years of active and happy life, for it is rather characteristic that the individual will live through childhood and adolescence with little or no disability. However, there comes a time, late in the second or early in the third decade, when complications are apt to appear. This fact is strikingly borne out by a review¹ of ninety-two autopsied cases of patients with a patent ductus arteriosus in whom the average age at death was 24 years.

Believing that the surgical obliteration of a patent ductus arteriosus would reduce the probability of subsequent bacterial infection and would also tend to forestall cardiac decompensation by reducing the

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The red blood count was 5,050,000 cells per cubic millimeter and the white count was 7,400 cells per cubic millimeter. The hemoglobin was 90 per cent and the blood smear was normal.

Operation.—On Sept. 12 surgical exploration was undertaken (by R. E. G.) under cyclopropane anesthesia. A curvilinear incision, concave upwards, was made just beneath the left nipple, running from the midline to the anterior axillary fold. The thoracic cage was exposed by transecting the lowermost portions of the pectoralis major muscle. The left pleural cavity was entered through the third intercostal space

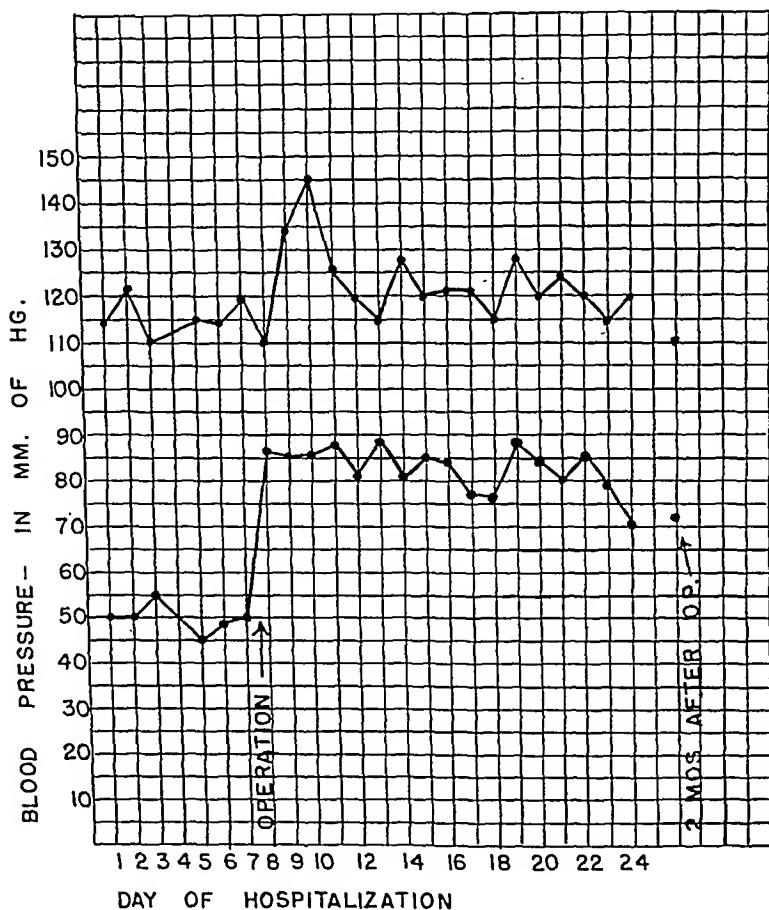


Fig. 1.—Daily blood pressure chart showing a striking rise in the diastolic level following ligation of the patent ductus arteriosus. Average daily diastolic pressure, 47 mm. of mercury before operation and 82 mm. of mercury after operation.

and the third costal cartilage was cut so that the rib could be retracted upward. With the chest open, the left lung was allowed to collapse into the inferior half of the pleural cavity so that an excellent view of the heart and the lateral aspect of the superior mediastinum was obtained. The parietal pleura which covered the aortic arch and pulmonary artery was now incised in a cephalocaudal direction for two and one-half inches, running from the base of the lung upward. After this pleura was incised and the subjacent fatty areolar tissue was dissected, the left recurrent laryngeal nerve was identified coursing around the lateral aspect of the aortic arch.

work of the heart, laboratory investigation was undertaken with an idea of finding a suitable operative approach to the superior mediastinum.² After some experience had been gained with the exposure of the aortic arch and pulmonary artery in dogs, a successful attempt was made to explore and ligate the ductus in the case of a human being.³ Having been encouraged by the satisfactory manner in which the first patient withstood the operation, we undertook the same procedure in the following case with equally gratifying results.

CASE REPORT

History.—R. C. was an 11-year-old boy who entered the Children's Hospital on Sept. 6, 1938, for study of his cardiac condition. His birth had been normal. At the age of 8 months his family physician made a diagnosis of "heart trouble." At 4 years of age he was brought to our outpatient department because of malnourishment. At that time the patient was thin and underweight. Auscultation of the heart revealed a loud to-and-fro harsh murmur which was most prominent at the base and to the left of the sternum. This was accompanied by a thrill which was almost continuous. A seven-foot x-ray film showed quite marked enlargement of the cardiac shadow, particularly to the left. There was a moderate prominence in the region of the pulmonic artery. The transverse measurement of the heart was 9.8 cm., compared to an internal diameter of the chest of 16.8 cm. The lungs showed a diffuse mild congestion, most marked in the perihilar regions.

At the present admission the child's chief complaint was that he tired easily "ever since he was big enough to run around." Dyspnea was never severe, yet the boy had long noted that he could not continue physical exercise as long as other children of his own age or size. At no time had there been cyanosis. On frequent occasions the patient had been conscious of his cardiac impulse and he had noted that it greatly increased in rate during exertion. The boy had always been slender and had gained weight very slowly.

Physical Examination.—The patient possessed a thin, ptotic build, the height being 58 inches and the weight 62.5 pounds. The important positive findings were limited to the cardiovascular system. The heart was enlarged to the left by percussion. There was a marked heaving of the chest in the apical region due to the very forceful action of the heart. Over the entire precordium there was a very loud, harsh, and roaring machinery murmur which was continuous but which was greatly accentuated during systole. This murmur had its maximum intensity in the second and third interspaces, just to the left of the sternum. Toward the apex of the heart, the diastolic element of the murmur was faint, but the systolic portion was quite loud. The systolic murmur was also heard loudly in both axillae, particularly in the left, and to a lesser degree it was heard over the back from the level of the second to the tenth thoracic vertebrae. A continuous thrill, accentuated during systole, was felt over the precordium, being most vibrant in the third left interspace. The second sound at the base was definitely accentuated. In the recumbent position the following blood pressures were obtained: right arm, 115/45; left arm, 120/55; left leg, 145/60; right leg, 160/60.

Laboratory Data.—Fluoroscopic and x-ray film studies of the heart showed a slight prominence in the region of the pulmonary artery. There was cardiac enlargement, particularly in the region of the left ventricle. The transverse dimension of the heart was 11.3 cm., compared to an internal diameter of the chest of 21.3 cm. The lung markings were diffusely increased. Electrocardiographic tracings showed an essentially normal record. There was no axis deviation. The urine was negative.

artery. From statistical evidence, the boy presumably was facing a rather high probability of subsequent cardiac failure of some degree because of the burden imposed by the ductus shunt. Furthermore, this congenital lesion carried with it a high risk of subacute bacterial endocardial infection. In the attempt to reduce the work of the heart imposed by the shunt and also to lessen the danger of subacute bacterial endarteritis, surgical exploration was undertaken for obliterating the ductus. The vessel was found to be 11 to 12 mm. in diameter and was successfully ligated. The patient stood the operative procedure with extremely little reaction.

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This nerve was carefully isolated and followed downward and medially until it led directly to a large and patent ductus Botalli.

The patent ductus in this case was 11 to 12 mm. in diameter and was approximately 12 mm. in length. It was exceedingly thin, its wall being about the same thickness and texture as that of a vein. The pulmonary artery was enlarged and was very tensely distended. As the fingers were placed on the heart and the pulmonary artery, a very vibrant thrill was felt. In fact, this thrill was so marked that during the subsequent dissection of tissue about the ductus a distinct tickling sensation was imparted through the instruments to the fingers. The length of the ductus raised hopes that the vessel could be freed, doubly ligated, and divided. As the ductus was being dissected away from the surrounding tissues, the thin vessel tore and a copious hemorrhage ensued. Bleeding could be controlled only by digital pressure while an aneurysm needle was cautiously passed around the vessel preparatory to ligating it. In view of this accidental opening of the ductus, it was deemed too dangerous an undertaking to continue with the handling of it, which would be necessary for its complete division. Accordingly, ligature alone was relied upon for closing off the shunt. Fortunately, ligature likewise controlled all bleeding from the torn vessel. After the ductus was tied, the thrill over the heart and pulmonary artery completely disappeared. A transfusion of citrated blood was given and the patient's condition was quite satisfactory. The lung was re-expanded with positive pressure anesthesia and the chest was closed without drainage.

Postoperative Course.—Following operation the boy made an excellent recovery. There was some local discomfort in the wound for two or three days, which was easily controlled with sedatives. On the fourth day he was permitted to sit up in a chair and at the end of a week was allowed to walk around the ward. The wound healed by first intention and the patient was discharged on Sept. 29, 1938.

The boy has been followed to date for a period of four months since his hospital discharge. His cardiac findings, from operation until this time, may be summarized as follows: The heaving and forceful nature of the cardiac impulse, as determined by inspection and palpation of the precordium, gradually has disappeared. At no time has there been a precordial thrill. For the first three weeks after operation there was a faint but definite to-and-fro blowing murmur over the pulmonic area, which was lacking in the rumbling "machinery" character which it had before operation. When seen at the end of two months, the diastolic element of the murmur at the base had disappeared and the systolic portion had become distinctly fainter. This systolic murmur could be barely heard over the midportion of the thorax posteriorly. The blood pressure was 110/72. In the four months since operation the child has gained nine pounds in weight.

The most striking objective change produced by ligation of the ductus was seen in the diastolic blood pressure. Before operation the daily systolic level varied between 110 and 124, with an average of 117 mm. of mercury; and the diastolic pressure varied between 54 and 35, with an average of 47. Following operation, the average daily pressures were 121 systolic and 82 diastolic. X-rays of the heart two months after operation showed no essential change in size or contour from the pre-operative findings.

SUMMARY

A case is reported of an 11-year-old boy who had typical physical and x-ray findings of a patent ductus arteriosus. As the child had been followed over a period of several years, there had been slight but definite hypertrophy (or dilatation) of the heart, this change being presumably caused by the large shunt between the aorta and pulmonary

jaundiced patients and frequently normal values are obtained even in the presence of actual hemorrhage due to the jaundiced state. The Ivy⁵ bleeding time has given neither consistent nor reliable results in this present series of cases. The measurement of the serum volume, as advised by Boyce and McFetridge,⁶ has not been used in this study, for Quick⁷ has stated that this test depends on the prothrombin content of the blood. Neither has the test of Smith, Warner, and Brinkhous been used as it was felt that this method was too intricate for general clinical use at present. In addition, it is not believed that such accuracy in the determination of the prothrombin level is necessary to observe and follow the bleeding tendency in jaundiced patients. At the present time the Smith test is being done on all cases of jaundice in an effort to determine what advantage it has over the simpler methods.

In this study the plasma clotting time, as described in detail below, has been used to determine the bleeding tendency. This test has been carefully checked by the Quick clotting method in several instances and has always been found to agree essentially with the plasma clotting time after interpretation. Quick has described his method in a recent publication.⁷

Lewisohn,⁸ Nygaard⁹ and Quick, Stanley-Brown, and Bancroft³ also have reported the prolonged plasma clotting time that may occur in patients with jaundice.

Plasma Clotting Time Determination—

Solutions: (1) Three per cent sodium citrate (3 gm. of reagent grade sodium citrate per 100 c.c. of distilled water). (2) M/40 calcium chloride (2.8 gm. of anhydrous or 5.5 gm. of hydrated calcium chloride dissolved in 1,000 c.c. of distilled water).

Method: With an autoclaved, dry needle and an absolutely dry syringe, approximately 5.5 c.c. of venous blood is drawn and placed in a 6 c.c. hematocrit tube containing 0.5 c.c. of sodium citrate. The blood and citrate solution are well mixed by slowly inverting the tube several times. This tube is then centrifuged at 1,000 r.p.m. for forty-five minutes and an estimate of the cell volume is made.

To each of three 100 by 30 mm. test tubes, containing 0.1, 0.2, 0.3 c.c., respectively, of calcium chloride solution, 0.1 c.c. of citrated plasma is added. The plasma clotting time is measured with a stop watch and is that time in seconds which elapses between the time the solutions are first mixed and placed in a water bath at 40° C. and the time a solid clot is formed. The test is repeated three times on all samples and, unless these agree within five seconds, another sample of blood is taken. If any hemolysis occurs, the sample is discarded. The temperature is very critical and variations of 1° may alter the clotting time considerably. It is essential that the test be done within one hour after the plasma is withdrawn from the vein, as plasma which has stood for longer periods may give different results than fresh plasma.

THE BLEEDING TENDENCY IN OBSTRUCTIVE JAUNDICE AND ITS CORRECTION BY MEANS OF VITAMIN K*

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SINCE Bancroft, Kugelmass, and Stanley-Brown¹ first suggested that a bleeding tendency in cases with obstructive jaundice could be foretold by an interpretation of the plasma clotting time as devised by Howell,² there has been a great stimulation in the study of the bleeding tendency of these patients. Quick, Stanley-Brown, and Bancroft³ have criticized the plasma clotting time of Howell as a measure of prothrombin because they believe that this method is altered by the thromboplastin or tissue extract which may be present in varying amounts in the plasma. They believe that this feature may be corrected by adding an excess of tissue extract. They have also stated, while speaking of the plasma of jaundiced patients, that "... the delay [of plasma clotting time in jaundiced patients] is not due to insufficient thromboplastin, for it is clear ... that excess thromboplastin does not restore the normal clotting rate as it does in hemophilic plasma." More recently Warner, Brinkhous, and Smith⁴ have devised a more elaborate and probably more accurate method for the determination of prothrombin which involves the precipitation of known solutions of fibrinogen by varying dilutions of unknown plasma from which fibrinogen has been removed. Both of these tests have been criticized, but they probably measure the peculiar quality or fraction of the plasma called prothrombin more accurately than the plasma clotting test of Howell.

As a practical test, the Howell method has distinct advantages and its value in determining a bleeding tendency in patients with jaundice will be discussed. Also an attempt will be made to show the curative effects of vitamin K and bile salts on the bleeding tendency of these patients as measured by the plasma and Quick clotting tests and by the patients' postoperative records.

METHODS

The usual methods of determining the bleeding and venous coagulation times are of little value in indicating a bleeding tendency in

*This paper forms a part of the study on the physiology and chemistry of blood coagulation which is conducted by Dr. Erwin Chargaff and associates in the Department of Biological Chemistry of this college. A portion of the expense of this study was defrayed by a grant from the American Medical Association to Dr. Erwin Chargaff.

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jaundiced patients and frequently normal values are obtained even in the presence of actual hemorrhage due to the jaundiced state. The Ivy⁵ bleeding time has given neither consistent nor reliable results in this present series of cases. The measurement of the serum volume, as advised by Boyce and McFetridge,⁶ has not been used in this study, for Quick⁷ has stated that this test depends on the prothrombin content of the blood. Neither has the test of Smith, Warner, and Brinkhous been used as it was felt that this method was too intricate for general clinical use at present. In addition, it is not believed that such accuracy in the determination of the prothrombin level is necessary to observe and follow the bleeding tendency in jaundiced patients. At the present time the Smith test is being done on all cases of jaundice in an effort to determine what advantage it has over the simpler methods.

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In normal blood the first appearance of a network of fibrin and the formation of a solid clot are almost simultaneous; whereas, in jaundiced plasma a solid clot may not form until fifteen seconds after the first shred of fibrin appears.

The highest normal plasma clotting time is considered to be 120 seconds and values above this figure indicate a prothrombin deficiency. Values above 150 seconds indicate a very marked bleeding tendency. Bancroft¹⁰ has found in nearly 5,000 determinations on all sorts of surgical patients, studied both pre- and postoperatively, that the average level is 100 to 105 seconds.

Determinations are done daily previous to operation and for five days after operation and at least every other day thereafter until the stools are continuously colored with bile.

Baldes and Nygaard¹¹ have described a coagulometer, by which the changes in the light absorption of the recalcified plasma as it clots can be recorded with great accuracy by means of a photoelectric cell. This apparatus greatly facilitates the determination of the end point of the clotting reaction both in the Quick and plasma clotting tests. It is not, however, essential for the performance of these tests.

EVALUATION OF PLASMA CLOTTING TIME

Twenty-four cases of obstructive jaundice were studied from the point of view of their bleeding tendency as measured by the plasma clotting time. Table I gives a résumé of these cases according to diagnosis and degree of jaundice as measured by the serum bilirubin. In 21 of these cases the diagnosis was confirmed either by surgical explora-

TABLE I
BLEEDING TENDENCY IN PATIENTS WITH OBSTRUCTIVE JAUNDICE
SUMMARY OF CASES STUDIED

DIAGNOSIS	NO. OF CASES	AVERAGE SERUM BILIRUBIN
Calculi in common bile duct	11	6.9 mg. %
Carcinoma of head of pancreas	5	14.3 mg. %
Stenosis of common bile duct	4	10.5 mg. %
Carcinoma of common bile duct	2	22.6 mg. %
Metastatic carcinoma (esophagus)	1	18.8 mg. %
(?) Aneurysm of hepatic artery	1	2.9 mg. %
Total	24	10.7 mg. %

tion or autopsy, and in the remaining 3 cases there were preponderant clinical and laboratory data suggesting an obstructive type of jaundice. Patients with obstructive jaundice due to neoplastic lesions are more likely to have higher serum bilirubin levels and absence of bile in their stools than those patients with jaundice due to biliary calculi in the common bile duct or stenosis of the common bile duct. Jaundice and colorless stools, in this latter group of cases, are more likely to occur intermittently. This will be discussed later in relation to the bleeding tendency.

Twelve cases (Table II) had preoperative plasma clotting times of 120 seconds or over and 9, or 75 per cent, of these cases bled to some degree after operation or within a relatively short period after admission. Four, or 33 per cent, of these cases bled severely, shortly after operation; and 3 of these latter cases died either from shock following hemorrhage or other causes augmented by hemorrhage. Five, or 42 per cent, of these cases bled from their wound or gastrointestinal tract for periods of two to twenty-one days after operation.

TABLE II
BLEEDING TENDENCY IN PATIENTS WITH OBSTRUCTIVE JAUNDICE
PATIENTS WITH PLASMA CLOTTING TIME MORE THAN 120 SECONDS

	NO.	AVG. PLASMA CLOTTING TIME (SECONDS)	AVERAGE SERUM BILIRUBIN
Malignant lesions	6	161	19.1 mg. %
Benign lesions	6	142	5.4 mg. %
<i>Postoperative Results</i>			
Died of hemorrhage and shock	2		
Death augmented by hemorrhage	1		
Serious postoperative hemorrhage	1		
Unusual but not serious hemorrhage	3		
Uneventful recovery	3		
<i>Nonoperative Results</i>			
Dead from hemorrhage (3 wk.)	1		
Bleeding from gastrointestinal tract	1		
<i>Summary</i>			
Total bleeding complications	9 (75%)		

The remaining 12 cases (Table III) fell into the group with plasma clotting levels below 120 seconds, and 3, or 25 per cent, of these cases bled postoperatively. Two of the 3 cases that bled postoperatively did not bleed until the twelve and fourteenth postoperative days, respectively, and in both instances surgical intervention had not returned bile to the gastrointestinal tract and marked prolongation of the plasma clotting time developed before hemorrhage occurred. The third case that bled in this group had a carcinoma of the common bile duct from which a biopsy was taken. A hematoma of the wound developed on the ninth postoperative day. Unfortunately the plasma clotting level was not followed after operation and this bleeding complication was not predicted.

While clinical histories are notoriously inaccurate as a method of estimating the amount of bile in the stools, it is of interest that 5 of the patients included in Table II, in whom bleeding was thought likely, gave a history of colorless stools for periods of three to five weeks and only 3 patients reported their stools as normal. In the group with plasma clotting times under 120 seconds, 3 patients reported colorless stools for periods of three days to two weeks and 5 stated that their

TABLE III

BLEEDING TENDENCY IN PATIENTS WITH OBSTRUCTIVE JAUNDICE
PATIENTS WITH PLASMA CLOTTING TIME LESS THAN 120 SECONDS

	NO.	AVG. PLASMA CLOTTING TIME (SECONDS)	AVERAGE SERUM BILIRUBIN
Malignant lesions	2	110	10.8 mg. %
Benign lesions	10	102	8.8 mg. %
<i>Postoperative Results</i>			
Died of hemorrhage on fourteenth postoperative day (after plasma clotting time had risen to 185 seconds)	1		
Died of anoxemia related to anesthesia, 24 hours	1		
Bled severely on twelfth postoperative day (after plasma clotting time had risen to 135 seconds)	1		
Hematoma of wound on ninth postoperative day	1		
Uneventful recovery	6		
<i>Nonoperative Results</i>			
Uneventful hospital course (jaundice subsided spontaneously)	2		
<i>Summary</i>			
Total bleeding complications	3 (25%)		
Bleeding complications not predicted	1 (8.3%)		

stools had been normal. The remaining patients either had intermittent periods when their stools were colorless or had some bile present regularly. The above figures were only considered after the clinical history was found to check with the stool examination on admission of the patients to the hospital.

The duration of the jaundice in these cases varied from seven days to three months and was of little value in relation to the bleeding tendency, as in many cases it had varied in degree and in other cases had probably existed for a considerable period before being noted.

The majority of cases were treated preoperatively for four to nine days and during this period were given high carbohydrate diets, glucose both orally and parenterally, and in many instances large doses of viosterol and bile salts as recommended by McNealy, Shapiro, and Melnick.¹² It is believed that all of these patients benefited systemically from this regimen, but there was no consistent or appreciable improvement in their plasma clotting levels.

Thus, in 14, or 58 per cent of cases, a bleeding tendency was predicted and 12, or 86 per cent. of these cases bled to some extent either postoperatively or within three weeks after the prediction was made. In 10 cases bleeding was not expected and in only 1, or 10 per cent, of the cases did any bleeding occur and this one complication was a hematoma which developed on the ninth postoperative day and might have been

foretold with more frequent postoperative determinations. There appears to be a gross relationship between the degree of jaundice, presence of bile in the stools, and the bleeding tendency as measured by the plasma clotting time, but the duration of jaundice is of little value in predicting which patients will bleed. In general, neoplastic obstructions of the biliary tract are more likely to produce a bleeding tendency than benign obstructions. The usual methods of preoperative treatment, as observed in this series of cases, resulted in no consistent or maintained diminution of the bleeding tendency.

TREATMENT WITH VITAMIN K

Dam and Schönheyder¹⁴ and independently Almquist and Stokstad¹⁵ discovered that the deficiency of an accessory food factor, later named vitamin K by Dam, in the diets of young chicks produced a bleeding diathesis and a marked decrease in the prothrombin level of the blood. The addition of this food factor to the diets cured this hemorrhagic condition in chicks. Vitamin K is present in green foliaceous vegetables, alfalfa, fish meal,¹⁶ bacteria,¹⁷ and in several vegetable oils,¹⁸ but its chief source is alfalfa. Hexane extracts of alfalfa meal yield potent concentrates and these concentrates have been used in this study. Thayer and co-workers¹⁹ recently have reported the crystallization of a potent material which they believe to be vitamin K. It is a fat-soluble vitamin and possibly an unsaturated hydrocarbon.²⁰

Although no definite vitamin K deficiency had ever been proved to exist in human beings and in fact has only recently been demonstrated in mammals,²¹ Greaves and Schmidt²² believed that, when the bile was decreased or absent in the gastrointestinal tract, a failure of absorption of vitamin K might occur. The stools of these patients and animals previously had been shown to contain adequate amounts of vitamin K.

Warner and co-workers²³ first reported the beneficial effects of vitamin K and bile salts on the bleeding tendency of obstructive jaundice in human beings. They fed these materials to patients with obstructive jaundice and found that a marked improvement in the prothrombin level resulted and could be maintained. Greaves and Schmidt²² showed that the bile salts served a valuable purpose in conducting fat-soluble vitamin K across the mucosa of the upper small intestine and into the portal circulation. Vitamin K effectiveness is greatly enhanced when it is given with bile salts. Dam and Glavind²⁴ found similar effects and Quick⁷ reported that low prothrombin levels due to obstructive jaundice, as measured by his method, were markedly improved after similar therapy. Butt and his co-workers¹⁶ also have confirmed this work.

In the present study, 14 cases of obstructive jaundice have been given vitamin K and bile salts and the results are summarized in Table IV. These patients all have been given approximately 1,000 units of vitamin

TABLE IV
SUMMARY OF CASES OF OBSTRUCTIVE JAUNDICE TREATED WITH VITAMIN K

No.	DIAGNOSIS	OPERATION	SERUM BILI-RUBIN AT ENTRY MG. %	DURATION OF ACHOLIC STOOLS	PLASMA CLOTTING TIME (SECONDS)		QUICK CLOTTING TIME (SECONDS)		DURATION OF TREATMENT (DAYS)	RESPONSE	POSTOPERATIVE COURSE
					AT ENTRY	AFTER TREATMENT	AT ENTRY	AFTER TREATMENT			
1.	Carcinoma of head of pancreas	Cholecystenterostomy	16.3	8 mo.	175	141	-	-	4	++	Uneventful
2.	Carcinoma of head of pancreas	None	11.6	3 wk.	204	108	29	22	6	++++	Died following severe gastrointestinal hemorrhage 3 days after treatment stopped
3.	Carcinoma of head of pancreas	Cholecystenterostomy	18.8	6 wk.	152	72	-	-	7	++++	Uneventful
4.	Metastatic carcinoma with portal obstruction	Cholecystostomy	20.8	3 wk.	168	102	-	-	7	++++	Died of renal failure; had severe gastrointestinal hemorrhage 4 days after vitamin K stopped
5.	Carcinoma of head of pancreas	Cholecystenterostomy	9.9	4 wk. intermittently	110	115	21	21	4	Maintained	Uneventful
6.	Calculi in gall bladder and common duct	Cholecystostomy	10.0	2 wk.	152	77	-	-	4	++++	Uneventful

7.	Calculi in gall bladder and common duct	Cholecholestomy Cholecystectomy	2.1 partial bil. fist.	4 wk.	158	130	-	-	4	++++	Uneventful
8.	Calculi in gall bladder and common duct	Cholecholestomy Cholecystectomy	8.1	2 wk.	151	119	25	19	4	++++	Uneventful
9.	Calculi in common duct	Cholecholestomy	5.8	10 mo. intermit- tently	185	169	-	-	2	0	Hematoma of wound
10.	Stenosis of common duct	Cholecholestomy	6.1	7 days	143	126	29	22	3	+++	No bleeding
11.	Carcinoma of head of pancreas	Cholecystenterostomy	23.4	6 wk.	146	127	24	22.6	3	++	Gastrointestinal bleeding on seventh and eighth postoperative days; malfunctioning enterostomy stoma
12.	Calculi in gall bladder and common duct	Cholecholestomy Cholecystectomy	8.0	-	104	85	19	18	4	Maintained	Uneventful
13.	Calculi in gall bladder and common duct	Cholecystectomy Exploration of common duct	7.5	0	156	119	-	-	3	++++	Uneventful
14.	Carcinoma of head of pancreas	Cholecystenterostomy	9.4	0	87	90	18.6	19	3	Maintained	Uneventful

K and 4 gm. of bile salts (bilron) per day for periods of two to seven days. Ten units is the equivalent of 1 gm. of crude alfalfa meal. The vitamin K was prepared by the research division of E. R. Squibb & Sons, New Brunswick, N. J., and the description of the unit recently has been reported by a member of that laboratory.²⁵

Thirteen of these patients underwent operation. In 7 cases the gall bladder was removed and the common bile duct explored. Five cases had some form of cholecystenterostomy performed and a cholecystostomy was done in 1 case.

On admission to the hospital, 11, or 79 per cent, of cases had plasma clotting levels of over 120 seconds and 3 cases, or 21 per cent, had normal levels. The 3 patients with normal levels at entry who were treated maintained normal levels during the preoperative period and had uncomplicated postoperative recoveries.

Of the 11 cases with prolonged plasma clotting levels at entry, 9 or 82 per cent, had levels of 150 seconds or over. The remaining 2 cases had levels of 143 and 146 seconds, respectively. In every instance except one, marked improvement of the plasma clotting time occurred during and after treatment with vitamin K. In the one exception there was considerable doubt as to the actual amount of vitamin K absorbed as the patient was vomiting intermittently and the bile salts and vitamin K seemed to aggravate this.

Of the 10 cases that responded to treatment, 6 cases fell to below 120 seconds or within normal limits. In 3 cases the plasma clotting time fell to 130 seconds or slightly lower and in the last instance it fell from 175 to 141 seconds.

The average plasma clotting time descended from a level of 150 seconds to 111 seconds. In 7 cases the Quick clotting time was recorded simultaneously and in every instance the findings had essentially the same significance. Twenty seconds has been the normal Quick clotting time used in this study. Rabbit brain dried by means of acetone was the source of the thromboplastin used in the Quick test.

Table IV gives a summary of the 14 cases treated with vitamin K and 10, or 71 per cent, of these cases recovered uneventfully. None of these patients were given treatment after operation as some were unable to tolerate the material because of nausea and others did not require treatment as they maintained normal plasma clotting levels after operation. Four, or 29 per cent, of these patients bled to some degree after operation and they will be reported in more detail.

CASE 2.—This patient gave a history of four weeks of painless jaundice, three weeks of acholic stools and marked pruritus. After six days of vitamin K and bile salts, the plasma clotting time fell from 204 seconds to 108 seconds. There was no clinical evidence of bleeding. The patient's general condition was poor and there was impairment of kidney function with marked nitrogen retention. Surgical intervention was deemed inadvisable. Three days after treatment was stopped, the plasma

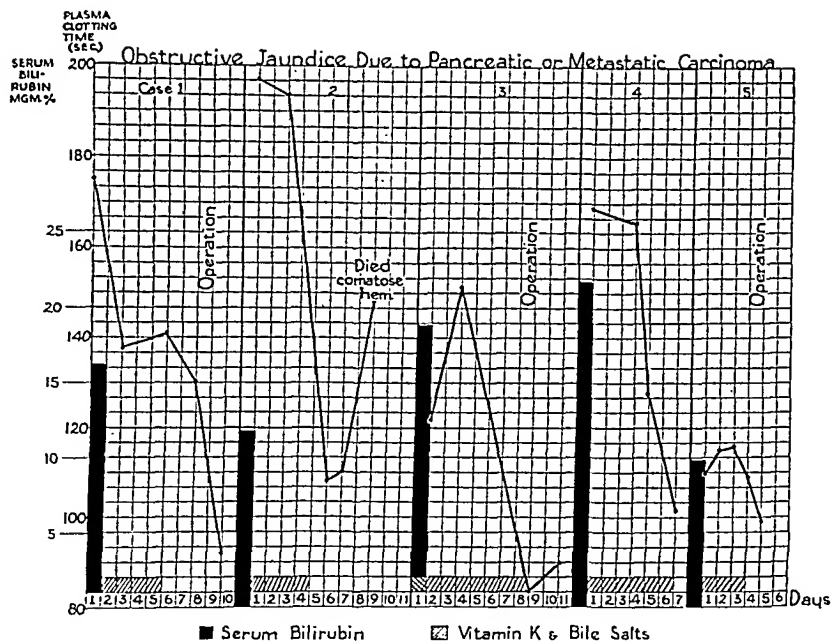
clotting time was 147 seconds and death occurred shortly after from a gastrointestinal hemorrhage and uremia. The laboratory data and clinical findings indicated a carcinoma of the head of the pancreas. No autopsy was obtained.

CASE 4.—Patient entered the hospital with a history of painless jaundice of five weeks' duration. The jaundice was accompanied by marked itching. Numerous excoriations and large purpuric areas were present on the thorax, shoulders, and legs. There was intermittent bleeding from the gums. The serum bilirubin was 20.8 mg. per cent and the plasma clotting time 169 seconds. Vitamin K and bile salts were given in addition to other supportive measures and in three days the purpuric areas began to clear and bleeding stopped from the gums. The plasma clotting time was 102 seconds before operation. At operation extensive peritoneal carcinomatosis was found, but the origin of the tumor was not ascertained. Large metastases were present in the region of the hilum of the liver, but the substance of the liver was uninvolved by tumor. A cholecystostomy was done. Four days after operation and after vitamin K was stopped, the plasma clotting time rose to 181 seconds and this was followed by extensive bleeding from the vagina, gastrointestinal tract, and wound; death occurred shortly thereafter.

CASE 9.—Patient entered the hospital with a typical history of calculi in the common bile duct. The plasma clotting time at entry was 185 seconds and vitamin K and bile salts were given. Because of intermittent vomiting, this material was only partially absorbed. After two days of treatment, the plasma clotting time was 169 seconds and operation was considered imperative. A choledochostomy was done and bile appeared in the intestinal tract. Uneventful recovery followed except for a hematoma of the wound. Unfortunately, no determinations of the plasma clotting time were made after operation.

CASE 11.—Patient entered the hospital with a six weeks' history of painless jaundice, pruritus, and acholic stools. The plasma clotting time was 146 seconds and fell to 127 seconds after three days' treatment with vitamin K and bile salts. At operation, a Roux type of cholecystenterostomy and enteroenterostomy were performed after an inoperable carcinoma of the head of the pancreas was found. The patient developed a partial intestinal obstruction and the cholecystenterostomy failed to function. The plasma clotting time rose to 179 seconds and moderate bleeding occurred from the gastrointestinal tract and there was oozing from the wound. Frequent transfusions improved the patient's condition, but another operation was refused and the patient was discharged on the sixteenth postoperative day against advice.

Fig. 1 indicates graphically the preoperative response to vitamin K therapy in five cases of obstructive jaundice, due either to primary carcinoma of the pancreas or to metastatic carcinoma. The first four cases all had markedly prolonged plasma clotting times which descended to normal limits after vitamin K treatment. The fifth case had a carcinoma of the head of the pancreas and maintained a normal plasma clotting level with treatment. This last patient did not have acholic stools. Fig. 2 indicates the same response in cases of jaundice due to biliary calculi or benign stenosis. Case 8 illustrates a partial improvement in the plasma clotting time in a patient who was vomiting during the initial part of the treatment period but who had a pronounced, sudden improvement after two days' treatment with a newer and more potent concentrate of vitamin K after vomiting had ceased.



The optimum dose of vitamin K is still a matter of dispute. In this present study approximately 1,000 units per day by mouth have been found effective in the majority of cases. It is entirely possible that larger doses might have been more effective or that smaller doses might have sufficed. Also, when parenteral material is available, it may be possible to treat successfully patients who cannot tolerate the material by mouth and to treat other patients in the immediate postoperative period. Occasionally, after long periods of treatment, diarrhea occurred and this was attributed to the large doses of bile salts administered.

DISCUSSION

Smith, Warner, and Brinkhous^{13, 26} have noted a precipitous fall in the plasma prothrombin level in dogs poisoned with chloroform or phosphorus. Recently, Warner²⁷ has found that the same fall in plasma prothrombin occurs after partial hepatectomy in rats and returns to normal during the period required for restoration of the liver to its normal weight. It would seem from this work that the liver is essential for the maintenance of a normal prothrombin level. Actual liver damage, however, is not essential for this decrease in prothrombin, as several observers^{22, 28, 29} have shown that very low prothrombin levels and marked bleeding diatheses develop in animals and patients with biliary fistulas. In these instances it has been noted that a slow decrease in the bleeding tendency occurs when bile or bile salts are fed. When vitamin K is given with the bile salts, there is a rapid decrease in the bleeding tendency.

Smith and his co-workers have suggested that vitamin K is either one of the building stones necessary for normal prothrombin production or that its presence stimulates the liver to a normal prothrombin production. Patients with obstructive jaundice or persistent biliary fistulas are likely to have little or no bile entering their gastrointestinal tracts and the fat-soluble materials in the intestines fail to become emulsified and are not absorbed. If this condition exists for any length of time, a deficiency of vitamin K and low prothrombin levels result. If adequate amounts of bile salts and large doses of vitamin K concentrates are given to these patients, the prothrombin levels may return to normal within twenty-four to forty-eight hours and prolonged bleeding and oozing has been observed to cease within this period of time. Smith believes that the effect of vitamin K is dependent on an essentially normal liver; he has given vitamin K and bile salts to patients with severe bleeding tendencies due to liver damage and has not found any decrease in the actual bleeding nor any beneficial effect on the prothrombin level. In this study one patient with advanced cirrhosis of the liver, severe jaundice, and a low prothrombin level was treated for ten days without any beneficial effect.

Blood transfusions long have been recognized as a method of combating the bleeding tendency in patients with obstructive jaundice, and this method of treatment is certainly indicated when actual hemorrhage or shock develops in these patients. Treatment with vitamin K should be given, as soon as feasible, to these patients as further bleeding complications may be avoided. Recently Rhoads and Panzer³⁰ have demonstrated the rapid fall in the prothrombin content of "stored blood." Similar work has been done at this laboratory and the prothrombin content of blood preserved in citrate may fall to 10 per cent of normal in forty-eight hours. This work implies that preserved blood would be of little value in overcoming a bleeding tendency due to a prothrombin deficiency. There are no actual data to prove this.

In any event, the usefulness of vitamin K and bile salts as a means of diminishing the bleeding tendency in patients with obstructive jaundice as reported here and elsewhere seems very encouraging. Vitamin K appears to decrease the bleeding tendency these patients may have or may develop more effectively than any other means.

SUMMARY

1. Twenty-four patients with obstructive jaundice have been studied from the point of view of their bleeding tendencies as measured by the plasma clotting time.

2. Twelve cases were considered to have bleeding tendencies because of abnormally prolonged plasma clotting times and 9, or 75 per cent, of these cases bled either after operation or after a short period of observation.

3. Twelve of these cases had normal plasma clotting times and were not considered to be potential bleeders. Three, or 25 per cent, of these cases bled after operation and in 2 of these cases the plasma clotting time became markedly prolonged before bleeding occurred.

4. Fourteen patients, 11 of whom had abnormally prolonged plasma clotting times, were treated preoperatively with vitamin K concentrates and bile salts.

5. Marked improvement of the plasma clotting time occurred in all but 1 case, or in 91 per cent of the treated cases, with abnormally prolonged plasma clotting times.

6. Seventy-five per cent of the cases in the group with bleeding tendencies, but not treated with vitamin K, bled postoperatively; whereas, only 36 per cent of a similar group treated with vitamin K had postoperative bleeding complications. No serious bleeding occurred in any patient while receiving treatment.

7. Vitamin K and bile salts appear to be very potent factors in decreasing the bleeding tendency which occurs in patients with obstructive

jaundice and the use of these materials in all cases of jaundice, both pre- and postoperatively, is recommended.

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CONSERVATIVE SURGERY WITH IRRADIATION IN GAS GANGRENE INFECTION

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AMPUTATION for many years has figured prominently in the treatment of gas gangrene of the extremities, both before and since gas gangrene antiserum became available. Case fatality records indicate a drop from 50 per cent mortality in those cases not treated by serum to about 25 per cent in those cases receiving serum therapy. In both groups amputation as a therapeutic measure has been widely advocated.

In the past five years articles have appeared sporadically in the American literature offering departures from the earlier treatment by the use of irradiation and sulfanilamide, usually used in conjunction with serotherapy, but as a whole disparaging amputation as an imperative, or even as a desirable, measure.

Irradiation.—Kelly first advocated irradiation in gas gangrene infections in 1933,¹ in 1936,² and in 1938,³ when he presented a still larger series and expressed an opinion that amputation was in most cases unnecessary.

In his 1938 series of 143 cases, most were those obtained through questionnaire, which makes their statistical value doubtful in that we do not see a representative cross section of all gas gangrene cases in their varied degrees of severity. However, this collection of cases has pointed the way for Kelly and his collaborators and has brought about a remarkable response from the radiologists questioned; and, in the absence of series of cases more representative than the isolated cases of various men, it is still the largest recording of clinical progress with irradiation. Faust,⁴ Bates,⁵ Turner,⁶ and several others have presented small series of their own, all expressing favorable results with irradiation. Results of these observers plus previously unreported cases from the Strong Memorial Hospital can best be divided into three divisions: (1) extremity infections without amputation, (2) extremity infections with amputation, and (3) infections of the trunk.

Charbonnet and Cooper⁷ reported 20 cases receiving irradiation, with only 2 deaths. Considering all cases reported regardless of classification, we find that the mortality is only 8.8 per cent, representing 14 deaths in 160 cases.

Sulfanilamide.—As to sulfanilamide, the only clear-cut examples are the three cases of Bohlman,⁸ for, although they had prophylactic serum, they subsequently developed a gas infection and received no specific

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to report which criteria were used, one can only compare the cases as presented.

In the seven years prior to 1935 in this clinic there were seen 12 cases of clinical gas gangrene of the extremities, 4 of these developing in the stump following amputation for other cause. In the other 8 cases, on recognition of the infection, immediate amputation was advised and performed except in 1 instance in which it was refused. This patient received only a small amount of serum and lived; while, of the remaining 7, 4 failed to survive, dying on an average of twenty-four hours after the therapeutic amputation.

TABLE II
STRONG MEMORIAL HOSPITAL CASES OF GAS GANGRENE*

	AGE	DATE	OPERATION	THERAPY	RESULT
1. A.P.	75	1928	Midhigh amputation preceded	50 c.c. serum	Dead
2. J.M.	61	1928	Therapeutic midhigh amputation		Living
3. J.K.	54	1929	Therapeutic midhigh amputation		Dead
4. A.S.	47	1929	Débridement (refused amputation)	10,000 units serum	Living
5. M.A.	52	1930	Therapeutic midhigh amputation		Dead
6. D.T.	19	1930	Therapeutic midhigh amputation		Dead
7. W.C.	71	1933	Midhigh amputation preceded		Dead
8. M.H.	60	1934	Therapeutic midhigh amputation		Living
9. L.B.	57	1934	Therapeutic midhigh amputation		Dead
10. J.B.	28	1934	Therapeutic midhigh amputation		Living
11. M.S.	43	1935	Midhigh amputation preceded		Dead
12. G.D.	72	1938	Midhigh amputation preceded	30,000 units serum	Dead
13. K.S.	44	1937	Therapeutic midhigh amputation	40,000 units serum 500 roentgen rays Sulfanilamide	Living
14. T.W.	85	1937	Midhigh amputation preceded	325 roentgen rays 8 gm. sulfanilamide	Dead
15. W.D.	70	1938	Therapeutic midhigh amputation	400 roentgen rays Sulfanilamide	Dead
16. C.M.	46	1938	Open reduction and débridement	550 roentgen rays	Living
17. F.T.	50	1938	Drainage	40,000 units serum 1,000 roentgen rays Sulfanilamide	Living

*Two other cases of *Cl. welchii* infection, both now living and well, are not included because there was no clinical evidence of gas gangrene although cultures were persistently positive.

In the past eighteen months, with introduction of x-ray therapy and sulfanilamide, out of 5 cases with both clinical gas gangrene and positive cultures, there have been 2 deaths, both in aged males. One had severe diabetes and lived for three days after a midhigh amputation.

Our recent cases which received irradiation are given in more detail.

CASE 13.—K. S., aged 44 years, was admitted Aug. 30, 1937, after having been struck by an auto, with compound fractures of left tibia and fibula, fractures of right tibia and fibula, laceration of scalp, concussion, and shock.

After combating the shock with heat and parenteral fluids, the patient was taken to the operating room and the grossly contaminated open wounds thoroughly cleansed with soap and water for "thirty minutes" and then débrided, and an open reduc-

TABLE I

	NUMBER CASES	ALIVE	DEAD
1. Cases irradiated and receiving no amputation present a mortality of 3.7%:			
Kelly collection	72	69	3
Bates	3	3	0
Faust	4	4	0
Schneider ⁷	1	1	0
Present case	1	1	0
	81	78	3
2. Cases irradiated but also receiving amputations present a mortality of 12.8%:			
Kelly collection	33	30	3
Bates	2	2	0
Faust	1	1	0
Present cases	3	1	2
	39	34	5
3. Irradiation in trunk infections presents a mortality of 20%:			
Kelly collection	18	14	4
Turner	1	1	0
Present case	1	1	0
	20	16	4

therapy other than sulfanilamide. We have used sulfanilamide in 3 of our cases, one of whom, a 70-year-old diabetic, died; but all 3 also received irradiation and there was no response directly attributable to the sulfanilamide. White¹⁰ has recorded 2 cases, both living, in which sulfanilamide was given, as have Fuller and Kellum,¹¹ but serum was also used. There has been no indication thus far as to how the drug exerts its action in this infection or what blood level is necessary for effectiveness. One disadvantage is the delay in establishing an adequate concentration of the drug in the blood, even with the sulfanilamide's being administered subcutaneously, for the disease is so rapidly fulminant any delay in establishing adequate therapy can easily be disastrous.

Statistical Studies.—The fallacies of statistical studies, especially in such small series, may lie in that amputations were performed only in fulminant cases and that the light and perhaps superficial infections were treated conservatively by x-rays or serum. To some extent this seems to be true.

Another fallacy involves the distinction between clinical gas gangrene infection and merely positive cultures of *Clostridium welchii* found in exudate or on the superficial wounds, for in the latter contamination is quite possible; or there may even be a superficial infection, usually mixed with the *Cl. welchii* organism but which is certainly not a true gas gangrene infection.

If we admit for comparison and study only cases with clinical signs and preferably positive smears or cultures of the infection, the objection that conservative treatment was allotted to only a selected group would be invalid within reason. Since the reported cases often fail

fection in the stump. From four days before amputation until death, the patient had received 5 gm. sulfanilamide daily, but no serum was given.

CASE 16.—C. M., aged 46 years, was admitted to the hospital on July 26, 1938, with a compound fracture of the left tibia and fibula and simple fracture of the left radius, ulna, and navicular bones received when he had fallen off a ladder. The open wound was scrubbed "for twenty minutes" with soap, water, and brush with copious irrigations with saline solution, and the reduction then done. The tissues were closed with catgut and with skin silks. The wrist was then reduced and plaster casts applied to both; 1,500 units of tetanus antitoxin were given.

On the fifth day a small amount of crepitus was noticed in the wound and a small amount of discharge was present. On the seventh day the appearance of a profuse, watery, brown discharge with crepitation exuding from the dark swollen tissues about the laceration over the ankle led to a diagnosis of gas gangrene, and the patient was taken to the operating room where the necrotic material was removed with a radio knife. There did not seem to be any involvement of the muscle itself, and the infection tracked upward on the medial side of the leg between the deep fascia and the subcutaneous tissue. A longitudinal incision was made over the tract and it was found to extend to a large pocket of pus going around the tibia at the point of fracture. Extensive drainage was installed and irrigations with Dakin's solution instituted. Cultures at this time showed *Cl. welchii* and a hemolytic *Staphylococcus albus*.

He was returned to the division and in the next three days received five irradiation treatments, totaling 550 roentgen rays. The progression of the infection seemed to be satisfactorily arrested, and no more irradiation was given, although the cultures have been intermittently positive for *Cl. welchii* until Dec. 20, 1938. It has been necessary to manipulate the joint several times to insure satisfactory position because of the severity of the displacement and the persistence of the chronic osteomyelitis which has ensued. The patient is up and well able to be about on crutches. Neither sulfanilamide nor serum was administered at any time.

CASE 17.—F. T., aged 50 years, was admitted Aug. 16, 1938, with diagnosis of gas gangrene in a perirectal abscess which had developed over a period of ten days. There was marked swelling of all perianal tissues, and a hard swollen red ridge of tissue extended anteriorly to the scrotum, which was four times normal size. Crepitation was easily felt about the rectum. The urine showed four plus sugar and acetone. He was given 20 units of insulin and 10,000 units each of vibron septique and *Cl. welchii* serum and was taken to the operating room where extensive incision and drainage of the infected tissues was carried out. He immediately afterward became profoundly ill and went steadily downhill during the next three days, despite repeated transfusions, 20,000 units each of vibron septique and *Cl. welchii* serum and sulfanilamide. By the second day discoloration of skin and crepitus had extended progressively through the left buttock, the flank, and through the left lower quadrant of the abdomen, where incision and drainage was again done. The scrotum and the shaft of the penis were likewise involved on the next day. Irradiation was started at this point and continued for three days for a total of 1,000 roentgen rays to the abdomen anteriorly and the left buttock posteriorly; during this time neither serum nor sulfanilamide was given. His downward course was arrested, and after the fifth day he began a slow improvement, complicated by furunculosis of the back and mild cardiac failure. He was discharged on the fifty-eighth day to a convalescent home, and now, five months after admission, is well enough to be up and about by himself and is ready for discharge to his home. His diabetes is controlled with 30 units of insulin daily.

tion of the left tibia and fibula effected. Suture of scalp and closed reduction of right tibia and fibula were performed.

On the second day there was exudation of thin, dark, bloody pus from the right leg wound, with discoloration of the skin and crepitus extending to just above the knee. The patient was taken to the operating room and a mid thigh amputation was done. He was returned to the ward and in the next forty-eight hours received 20,000 units each of Lederle's and Mumford's gas gangrene serum and a total of 500 roentgen rays to the stump. The posterior portion of the stump obviously was infected with exudation of a thin, gas-containing exudate, and with crepitus extending upward several inches.

He was intensely ill the first three days; from then on he slowly recovered, although the cultures from the stump were positive for *Cl. welchii* for the subsequent weeks. He also received five transfusions, totaling 2,700 c.c., had a short course of prontosil, and had irrigations with Dakin's solution. His convalescence was complicated by appearance of an abscess over the right aspect of the sacrum which was crepitant. On incision, pus and gas were evacuated, and the cultures were again positive on several occasions for *Cl. welchii*. He was subsequently discharged to a convalescent home on his fifty-first day, although the stump was still superficially infected and the cultures still positive for *Cl. welchii*. He was reported alive and well thirteen months later, with the infection cleared.

CASE 14.—T. W., aged 85 years, was brought to the hospital Dec. 16, 1937, because of a circulatory disturbance in the right foot which was found to be cold, swollen, and bluish, with coolness and impairment of color extending halfway to knee. A diagnosis of arteriosclerotic vascular disease was made. Because of advanced age with already established arteriosclerotic heart disease, pavex treatment was instituted for nine days with no improvement.

Under spinal anesthesia a mid thigh amputation was then done. The next day the patient appeared quite ill, with a temperature of 40° C.; he began a downhill course with depression of all vital signs and developed fluid in the lung bases. On the fourth day he looked slightly better, but, because of tension on sutures, they were removed with evacuation of 100 c.c. of thin bloody material with a hydrogen sulfide odor.

The discharge continued to drain next day, and cultures revealed *Cl. welchii*. The patient looked much weaker and it was decided to use no serum. In the next twenty-four hours he received 325 roentgen rays to stump and two infusions of sulfanilamide, 4 gm. each, but the patient died shortly afterward.

CASE 15.—W. D., aged 70 years, a known diabetic, was admitted on Aug. 15, 1938, because of persistent ulceration and beginning gangrene of foot. Urine was strongly positive for sugar. There was a frankly necrotic area over the metatarsophalangeal joint of the great toe on the right foot surrounded by edematous tissue, with area of softening in middle.

Attempt was made to regulate his diabetes, and an incision and drainage of the abscess of the foot was carried out. Culture on the next day showed *Staphylococcus albus*, nonhemolytic streptococcus, *B. coli* and *Cl. welchii*. During the next two days he received 400 roentgen rays to the foot, but the involved tissues of the foot were discolored, no granulations had formed, and he appeared weaker. His temperature was never below 38.0° C. There was no evidence of clinical gas gangrene until thirty-six hours after the last x-ray treatment, when crepitation was felt through the distal two-thirds of the foot with discoloration of the skin, which on incision yielded pus and gas bubbles.

Under spinal anesthesia a mid thigh amputation was done, but the patient failed to rally, went steadily downhill, dying in two days. There was no evidence of in-

in the wound which remained from the injury and was not necessarily a result of the necrotizing toxin. However, Lilienthal¹⁴ finds that in surgery of lung abscesses the topical application of the antiserum seems to reduce the number of indolent gangrene infections of the chest wall so prone to occur.

Irradiation Instead of Amputation.—When irradiation was introduced by Kelly in 1933, there was still no method other than surgery (and the possible local effect of the antisera) of controlling the local infection, and the rationale of replacing surgery by irradiation soon became obvious to him and his co-workers.

In the meanwhile, Pasternack and Bengtson¹⁵ illustrated with vibron septique that there were obvious and predictable systemic lesions produced experimentally by its toxin and that there was almost an affinity of the toxin for the heart where small areas of necrosis could usually be found. With this in mind, Kelly suggested that irradiation might possibly have an effect on the exotoxin and advocated the use of irradiation over the heart in case this were true, although it has never been established that any such relationship actually exists.

If one can assume with Kelly that amputation in these infections is never warranted except where the extent of the injury itself would justify it, a great step in the treatment of the local lesion would be made. Whether this holds true in deep infections as well as superficial, in extensive and rapidly spreading ones as well as in the smaller and well-localized lesions, is still not established, although the evidence partially confirms this view.

If amputation can be dispensed with, then the question of the necessity or extent of débridement arises. Can one rely on irradiation enough to treat the infection just as one would treat an infected open wound of other origin with removal of obviously necrotic tissue, drainage, and irrigation? Should one do a wide débridement removing all suggestively affected tissue until an undoubtedly clean field remains as has been the custom in the past? Or can one go to the other extreme and, after arranging for drainage, depend on the natural defences and x-ray and serum for the rest, refraining from any more trauma to the tissues? Kelly appears to advocate the first course, while Hanchett¹⁶ and most other contributors still favor more radical measures. To justify the ultraconservative course, one can demonstrate the success in infections of the trunk where even débridement is attempted much less frequently and where grossly involved tissue has not even been incised and yet recovery has ensued without any slough following. The length and intensity of irradiation can depend only on the clinical course. The extension of the infection can usually be followed by the discoloration of the skin and deeper tissues, and by the crepitation, although following irradiation the latter is of less value, for, although the bacilli may have been killed, some gas may persist. This occurred in Case 17 over

Attitude Toward Amputation.—The prevailing attitude of the greater proportion of surgeons today in favor of radical surgery in cases of gas gangrene infections has much precedent but fails to justify itself now that other methods of treatment are established.

Before the World War, high amputation at first sign of gas infection in the tissues was a *sine qua non* enforced on the surgeon by bitter experience with the rapidly fulminant course of an infection which, if left alone, was almost uniformly fatal. When serum was introduced, it was possible to reduce the mortality from 50 to 25 per cent, and here again amputation, or at least radical surgery, was continued, and fairly logically, for the action of the serum is not to control the local lesion but to combat chiefly the far-reaching systemic action of the *Cl. welchii* toxin. This has been partially overlooked, for the evidence that a true exotoxin is liberated was first presented by Bull and Pritchett¹² in 1917 when they compared the exotoxin as similar in mode of production and immunologic reactions to that of *Bacillus diphtheriae* and *B. tetani*. However, they found there to be at least two components to the exotoxin: an hemolysin causing blood destruction, and one acting locally, "causing edema and necrosis and probably exerting general toxic action." These observations are quite in harmony with the fact that the *Cl. welchii* is pathogenic in the tissues only when a foreign material or dead tissue is present, or when some of its own exotoxin is present which is able to destroy enough tissue for the infection to gain headway.

Thus, for the first time was the treatment of the infection put on a logical basis: the treatment of the local lesion by amputation or complete extirpation, the neutralization of the exotoxin by the specific serum. Technically this was more difficult than apparent because there were numerous strains of *Cl. welchii* and also there were other anaerobes often responsible, so polyvalent sera were made available, since it was obviously impossible to identify the strain before treatment was instituted.

Thus, while it is fairly well proved that the serum has its action on the exotoxin and is thus able to combat systemic involvement, the action at the site of the infection is much less clear. Lahiri¹³ recently has shown that the protection afforded by the antitoxic, anti-Welchii serum is decidedly better than that of the antibacterial serum, both in immediate and delayed experimental infection. There is no evidence as yet to prove that the antitoxic antisera have any effect other than the neutralization of the toxin at the local lesion, although in this way they prevent the necrosis of tissue so essential to the furthering of the infection.

Bates,⁵ Bohlman,⁹ and Fuller and Kellum¹¹ have recorded cases in which, after prophylactic serum had been given, infection nevertheless had developed, which suggests that either the serum was not specific for the strain or that the infection was developing about dead tissue

4. The use of irradiation alone or with other agents has shown an unmistakable decrease in the case fatality.

5. Whatever are the relative merits of x-ray and serum, more pressing is the re-evaluation of amputation in gas gangrene infections. Indications for amputation are far different from those of ten years ago, and the necessity and time and extent of radical surgery can be clarified only by future reports.

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the anterior abdomen, and, although no further irradiation was given, the gas disappeared and there was eventual recovery. While this infection is usually said to travel through muscle groups chiefly, there was little doubt that most of the extension in this same case took place through the subcutaneous tissue, dissecting from the left buttock all the way around to the left lower quadrant of the abdomen, and, when drainage was established over the symphysis and anterior spine, there seemed to be no involvement except of the subcutaneous tissue. This subcutaneous extension of the infection had been noted in several of the earlier cases also.

It is regrettable that reports concerned with irradiation have not appeared more in the general surgical journals, for, although most roentgenologists are well informed of the merits of this mode of therapy, it has not been brought sufficiently to the eyes of the general surgeon. As late as 1937, Thorek¹⁷ said: "Once the condition has started there is but one treatment and that is surgical. This may be in the form of massive débridement associated with multiple incisions extending into normal tissue or in advanced cases, immediate high amputation." He failed even to consider the recent development of more conservative measures.

The most recent measure¹⁸ introduced for the treatment of these infections is the administration of oxygen by inhalation. While the use of high concentrations of oxygen has been shown to have a bactericidal effect on numerous bacteria, both aerobes and anaerobes, theoretically the latter should be more easily affected. In gas gangrene the action is presumably double. There is the direct action of the increased oxygen tension on the organisms, and second the indirect action through the decompression of the nitrogen distending the tissues. This method has not yet been used at the Strong Memorial Hospital.

SUMMARY

1. Radical surgery has been predominant in the treatment of gas gangrene infections both before and since the introduction of the specific antiserum as the only possible means of adequately controlling the local infection.

2. Since the introduction of irradiation and sulfanilamide as therapeutic agents in this disease, it has been amply shown that the infection can be controlled and cured without amputation, and even without surgery in numerous cases which would have undoubtedly been operated upon immediately several years ago.

3. Treatment with sulfanilamide is still limited to a few cases in the literature where its effect has not been confused by other agents, although its use has been widespread in conjunction with other agents, but with as yet no definite proof of efficacy.

Most of the patients have been men past middle life, although a number of cases in women and several in children have been reported. Some of the cases have been preceded by a pharyngitis or throat infection. Erysipelas preceded one. Tooth extraction preceded one and influenza preceded another. One case followed some years after mastoiditis. The neck is the site of the infection in most of the cases, although an abdominal wall involvement³ and upper arm involvement⁴ have been reported.

Some days or even weeks after the initiating lesion, an area of induration appears, in most cases in the carotid region of the neck. This is first noted as a stiffness with some soreness, but pain is not marked and may be entirely absent. Many of the cases have been entirely afebrile, but those which we have observed fluctuated below 100°. The leucocyte count is only slightly elevated and differential white cell relations are not much disturbed. The patients do not feel prostrated, eat and sleep well, and do not lose weight rapidly.

Very gradually the induration, which ordinarily is first noted rather deep in the tissues of the neck, apparently in the deep fascia about the carotid sheath, extends laterally and toward the surface. Possibly it also extends more deeply at the same time, as Suchy⁵ reports a case with tracheal compression, Reclus¹ a death from edema of the glottis, and Capasso⁶ a death from compression of the cervical cord, the latter apparently one of direct extension of the inflammation. At first the skin appears normal and is movable over the advancing induration, but later it becomes adherent. It also becomes indurated and assumes a bright or dusky red color. Writers from European countries speak repeatedly of its "wine-red" appearance. There is no tenderness. Eventually the skin, subcutaneous, and deep fasciae and their contained structures are fused into a relatively rigid mass.

Much later, and only in occasional cases, small abscesses form in the involved tissue, break down, and drain or are drained, without much effect upon the surrounding process. Reclus¹ found such abscesses in two of his cases. In one, five abscesses appeared successively at widely separated points. Ashurst,² who excised a woody phlegmon en bloc under the impression that it might be either tuberculosis or a neoplasm, found an encapsulated abscess in the specimen, the existence of which was not apparent before the operation. Persistent sinuses are not formed.

The process of recovery from the inflammation occurs as gradually and steadily as its onset. The plaque, which often extends from the level of the hyoid to the clavicle and from the midline in front to the midline posteriorly, softens. The skin becomes looser and more pliable; the color fades. The duration of the process varies from a few weeks to over a year from onset to recovery.

WOODY PHLEGMON OF THE NECK

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WOODY phlegmon of the neck is a term proposed by Reclus¹ to identify a characteristic disease process which had a different appearance, a different clinical course, and a different outlook than other inflammatory processes in the neck with which we are familiar. Time and subsequent authors have seemed to justify the opinion that it is an entity. It is perhaps unfortunate that the descriptive term, while most applicable to the disease in question, implies physical characteristics that are found in many other pathologic developments. As a result, most medical men fail to distinguish between this process, the totally different process that we know as Ludwig's angina, and the more common forms of infection of the lymphatics and fascial planes that have not gone on to abscess formation.

There is always a temptation to draw distinctions where no real difference exists. Ashurst divided medical men into two groups: first, a Hippocratic group who object to unnecessary multiplication of diseases and wish to assign so-called new diseases to their proper places under already recognized pathologic processes; and second, a Cnidian group for whom every new symptom and every complication constitutes a new disease. There is no question but that our whole effort is and should be toward the Hippocratic rationalization. And yet, when the life history of a disease is as distinctive as that of woody phlegmon, there is utility in the Cnidian method until an exact etiology is worked out. At present we know the onset, course and outlook; we think we know something of the predisposing factors, but we do not know why the process occurs or whether its individuality is one of the host or of the infecting agents.

Reclus¹ in 1893 described three cases in which there was a slowly progressive, infiltrating, inflammatory process in the neck. There was little pain and only slight and occasional fever. The induration began in the fascial layers, but gradually the anatomic layers became frozen together; the skin became involved and adherent to the deeper structures. In one case minute abscesses appeared after some months, which were drained without much effect upon the rest of the process. The second case died of asphyxia after the glottis became involved. In 1895 he described two more cases. In all cases a large area was involved, and always slowly. Weeks and sometimes months were required for the development of the lesion, and almost a year for its resolution.

With the concept that the process owes its individuality to the altered response of tissue to an attenuated infecting agent, it is easy to comprehend the indistinct borderland between it and the more common and familiar pyogenic infections of the neck. The latter habitually run a more rapid and acute course. They have more fever, pain, leucocytosis, and end more rapidly in either resolution or suppuration. Because of the name and physical characteristics, many surgeons confuse this slowly progressing wood phlegmon with the totally different, rapidly progressive pyogenic phlegmons of which Ludwig's angina may be taken as the type. In these, the fascial planes are involved by direct extension, the induration is boardlike, as in the true woody phlegmon of Reclus; but the course is short and stormy, the lack of suppuration is due to the overwhelming virulence of the infection rather than its benignancy, and either the infection or the host is triumphant within a period measurable by days. Incisions for the relief of tension and the eventual establishment of drainage seem to be quite valuable in these cases; whereas, they are almost valueless as a therapeutic measure in the woody phlegmon of Reclus unless abscesses develop.

Occasional difficulty in differentiating a rapidly infiltrating carcinoma of the neck will arise, particularly if it is branchiogenic or if the primary focus is not found. Schminke¹⁷ reports such a case of a patient with a "typical" woody phlegmon who died of coronary thrombosis after progressing for a number of weeks. Post mortem revealed that the extending induration was due to a carcinoma. However, ordinary care in search for primary foci and biopsy where necessary will guard against this confusion.

Tuberculosis of the neck ordinarily will not constitute a differential problem as it is primarily limited to the lymph nodes and extends to the fasciae and skin only to a slight degree as a periadenitis unless a frank cold abscess has formed. And yet, as careful a man as Ashurst made a block dissection and excision of a woody phlegmon in its sixth week because he thought it either a tuberculous adenitis or a neoplasm.

Actinomycosis of the neck may be more difficult to eliminate, but there is ordinarily a demonstrable connection between the atrium of infection and the extending lesion that is absent in woody phlegmon. The direct extension and involvement of all intervening tissues are common to both, but the multiple and persistent sinuses of actinomycosis are early and characteristic, and the ray fungus is not unduly hard to find.

Gumma of the sternomastoid muscle probably should be included in any academic discussion, but the anatomic site of the initial induration and the lack of widespread fascial involvement will suggest the proper explanation, while the history and serologic studies will corroborate it.

Treatment has varied widely. Powers used autogenous vaccines and Reclus used diphtheria antiserum. Many authors have incised the small

As may be suspected from the foregoing, the pathology of the process is one of simple fibroblastic proliferation. Grossly, the tissues appear whitish and hard and avascular. In one case which I incised along the posterior border of the sternomastoid muscle down to the level of the carotid sheath, no vessels bled sufficiently to require clamping. Histologic examination of Ashurst's² excised specimen is reported to have showed chronic inflammatory changes in lymph nodes and surrounding fibrous tissue. The extension has involved the deepest tissues in the neck and has repeatedly threatened to pass down into the mediastinum, as it did in one of my cases. I have, however, found no reports where the latter extension actually occurred.

Bacteriologic studies have been made in many cases, and with varied results. The pus within the abscess in Ashurst's case was sterile. Others have found streptococci, staphylococci (albus and aureus), proteus-like organisms, diphtheroids, and diphtheria organisms. Merkel⁷ reports the case of a slaughterer who, after butchering an actinomyotic animal, held the knife in his mouth. A woody phlegmon of the neck developed from which streptococci were recovered without actinomyces. Powers⁸ made an autogenous vaccine from streptococci, staphylococci, and pseudo-diphtheria organisms found in one of his cases and thought he perceived benefit from its use. Reclus used diphtheria antiserum in a case from which he recovered a diphtheria-like organism, after which the patient made a slow recovery. The variety of the flora suggested to Reclus that the disease was the response of lowered resistance on the part of the host toward infection with attenuated varieties of many facultatively pyogenic organisms, either singly or in mixed growth. Subsequent writers appear to agree with him, but many stress the resemblance to fungous infections and granulomas in the pathology and course of the disease. The clinical resemblance to the cladothrix infection, known as erysipeloid, is striking. Sick⁹ suggests that two of Reclus' cases may have really been actinomycosis, but it is quite obvious that this disease has been eliminated from consideration in the later cases both by the clinical course without abscess formation or sinus drainage and by bacteriologic studies.

Since Reclus, many authors have contributed to the subject.¹⁰⁻¹⁸ Out of thirty-eight reported cases, I was able to find records of only two deaths, a mortality of 5.26 per cent. One of these deaths was due to edema of the glottis,¹ and one to compression of the cervical cord by direct invasion of the inflammatory process.⁶ The age of the patients varied from the 4-year-old daughter of one of the authors¹⁶ to 50 years. Males were somewhat, but not strikingly, more often afflicted than females. The shortest duration was two weeks and the longest was thirty months. The average case appeared to recover in three to five months.

was lifted up until an iodoform gauze pack could be inserted behind the clavicle, just below the edge of the induration.

Potassium iodide and hot applications were started on her admission, and x-ray treatments were started after the incision. Very slowly the induration softened in the deeper tissues from the edge toward the center, and the color of the skin became a darker red and then faded. She was discharged from the hospital Dec. 22, seven weeks after the onset. She was followed at home, and, by the end of February, the induration had entirely disappeared, four months after the onset.

CASE 2.—C. H., aged 50 years, entered the Presbyterian Hospital on the service of Dr. Kellogg Speed, July 2, 1926. One week previously a friend had squeezed a boil in the patient's left parietal region. An advancing, very hard induration had formed in the left neck, eventually reaching the clavicle. It was red, with adherent skin and fascial planes, and was only slightly tender. On Aug. 18 and again on Sept. 1, Dr. Speed incised and drained localized abscesses from which were cultured, in the first instance, a very sparse growth of hemolytic staphylococci, and, in the second abscess, slightly hemolytic streptococci. His temperature fluctuated about 100°, except as the abscesses formed, when it each time rose to about 103°. The leucocyte count was 13,000 on admission. He was discharged two months after the onset "much improved." The induration was still present but was fading out.

CASE 3.—C. A. C., a 6-year-old colored boy, had a past history which was irrelevant except for a history of exposure to a case of pulmonary tuberculosis. In the spring of 1933, the mother noted a painless swelling in the right side of the neck. She thought this to be anterior to the present area of trouble. It disappeared without much attention being paid to it. On Oct. 4, 1933, the child stayed in the house all day and said he had a toothache. The mother investigated and found a tender, fixed mass in the side of the neck. She thought there was some temperature at first, but it was not taken with a thermometer. The first physician consulted spoke of mumps, and a second spoke of a glandular involvement and advised hospitalization.

He was admitted to the Presbyterian Hospital on the service of Dr. Clifford Grulee, Oct. 25, 1933. At that time, physical examination was negative except for the neck. "On the right side of the neck, extending from the spine to the clavicle, is a hard, somewhat tender mass. The glands on the opposite side of the neck are hard and somewhat shotty to the palpating finger." During his three weeks of hospital observation, his temperature, with one exception, was practically normal. On one day it rose temporarily to 102.2°, the reason for which was not made out. Otherwise, it stayed close to the normal line with occasional rises to 99.4° and 99.2°. His leucocyte count varied between a high of 10,050 and a low of 7,700. Differential counts were essentially normal. The Mantoux and Wassermann tests were negative.

Hot dressings were applied and without other therapy the child steadily improved. On Nov. 14, he was discharged with the following notation by the resident: "The diagnosis on admission was apparently quite simple—that of abscessed lymph gland of the neck. However, within a few days, the swelling became very firm and led to a diagnosis of woody phlegmon. Upon persistent treatment with hot moist dressings, the swelling diminished in size, the child grew continually more comfortable, and the temperature remained normal except for an occasional rise. At the time of discharge from the hospital, the swelling had completely disappeared but there were still a few enlarged glands in the region. His temperature was normal and condition apparently excellent."

CASE 4.—C. G., a man 45 years of age, whose past history was irrelevant except that he had had a tonsillectomy three years previously, entered the Presbyterian Hospital, Feb. 17, 1932. He stated that four or five weeks previously he had had "flu" for three days which cleared up readily. Eighteen days previously he had noticed a

late abscesses as they appear, but this has had little apparent effect on the course of the disease. Ashurst's case recovered after a very wide excision of the involved tissue done under temporary occlusion of the carotid artery, and other authors have recommended wide excisions of the diseased tissue where it was practicable. However, such procedures, or even wide incisions, seem hardly justified in a disease process which tends so definitely toward spontaneous recovery. Tracheal pressure and edema of the glottis as complications, of course, will present their own indications for interference. In one case here reported, after having watched the induration for some weeks gradually approach the inlet to the mediastinum under the sternomastoid muscle, I made a wide incision and placed an iodoform gauze pack below the advancing edge of the process, thereby hoping to stimulate limiting granulation tissue. The advance then stopped. I am not, however, convinced of the utility of this action. While many authors have reported their fear as to mediastinal involvement, I do not know that it has occurred. Many men have used potassium iodide in large doses, empirically and because of the similarity between the progress of this infection and the other granulomas in which iodides are useful. General hygienic measures to build up the patient are probably useful. In one of the cases here reported, after hot moist dressings, bed rest, and potassium iodide had failed to affect the steady extension of the induration, the institution of x-ray treatments coincided with the beginning of its recession. Whether the relationship was more than one of coincidence is difficult to say.

CASE 1.—R. S., a woman 44 years of age, developed a sore throat on Nov. 3, 1934. Shortly afterward, the right side of her neck became stiff and swollen. She felt tired and had some generalized aching but no fever. She remained up and doing her housework until ordered to bed by her physician on Nov. 10. The mass slowly increased in size, limiting her ability to swallow anything but liquids and interfering with the movement of her head.

She was admitted to the Presbyterian Hospital, Nov. 15. At that time, there was an indurated, nontender, very hard mass in the right side of her neck about 10 cm. in diameter and about 3 cm. thick. In this the skin, superficial fascia, and deep fascia were adherent to each other. The margins of the mass were distinct and it felt like a plaque. The skin over the central part was dark red without local heat. There was no fluctuation. Motion of the neck was mechanically limited by the plaque. Her pharynx appeared normal except for absent tonsils, which had been removed ten years previously.

Her temperature fluctuated between 100.2° and normal for the first three days, after which it slowly fell to normal by the third week. There were occasional slight rises after that. Her leucocyte count varied between 15,600 and 22,000.

By Nov. 19, the induration had extended from the midline in front to the spinous processes posteriorly, and from the mastoid to just above the clavicle. At that time an incision was made over the posterior border of the sternomastoid muscle. The skin was adherent to the superficial and deep fasciae. They in turn were grayish white, thickened, and friable. There was edema but no pus beneath the sternomastoid, which

from it pus was aspirated. This reaccumulated and was the reason for her hospital admission. During her year of illness, her appetite remained good. She tired easily but had lost only five pounds from her average 147 pounds. On admission her temperature was 101° and her leucocyte count was 7,300. On Nov. 19 the abscess at the posterior wall of the sternomastoid muscle was incised and material taken for culture, guinea pig inoculation, and tissue sections. The granulation tissue was reported by the operator at the time to be "white and friable, and more the color and consistency of tumor." The guinea pig inoculations were negative as were the anaerobic and Sabouraud's medium cultures. An abundant growth of hemolytic streptococcus was obtained. The tissue sections showed young granulation tissue infiltrated with round cells and plasma cells. There were only occasional polymorphonuclear leucocytes in most of the tissue examined. In some sections there were granular eosinophilic leucocytes.

The patient left the hospital on the third postoperative day. Her subsequent course has been excellently described by Loewe.¹⁹ She continued to have draining sinuses. In February, 1933, a sporothrix was isolated from the discharge. Under vaccine therapy against the sporothrix and streptococcus, there was striking improvement. In April, 1934, treatment with phenylmercuric nitrate locally was instituted, and by June 6, 1934, the patient was well. She has remained so since.

CASE 7.—J. O., 50-year-old farmer, entered the Presbyterian Hospital on the service of Dr. Nicholas Senn. Three weeks before admission he thought he got a barley burr in his mouth while threshing. Swelling of the neck began immediately thereafter and increased steadily until his admission, at which time there was enlargement under his chin which involved all the anterior aspect of the neck so that there was nearly a straight line from the symphysis mentis to the sternum. The neck was hard and hyperemic, pitted slightly on pressure, was not tender, and did not fluctuate.

Under general anesthesia a four-inch incision was made in the median line and lateral incisions about two inches long were made on each side. Although no pus was found, drainage tubes were inserted. Further progress of the patient was not given. There was insufficient detail to classify this case. It was diagnosed by Dr. Senn as a Ludwig's angina, but it is evident that the history and findings are not characteristic of this. Actinomycosis of the neck or woody phlegmon are the most likely possibilities. The case is not sufficiently characterized to be included in this group with certainty and is only mentioned for what statistical value it may have.

During the same period in which the foregoing cases were seen in the Presbyterian Hospital, there were 8 cases of frank Ludwig's angina. Of these, 6 followed dental work, 1 followed acute tonsillitis, 1 followed mastoiditis (Bezold abscess and phlegmon of the neck). Of these, 1 was discharged against advice, still with sepsis, but the case was not followed. Four recovered (duration of 63, 58, 17, 12 days); 3 died (duration of 17, 8, 4 days). (Ashurst reported a mortality of 5 out of 18 cases, or 27.7 per cent.)

SUMMARY

Certain cases of chronic, low grade phlegmon in the neck appear to constitute a clinical entity. The course is indolent and the prognosis, in general, is good. The etiology has not been established, but infection by one of the higher bacterial forms seems probable. Radiation, iodides, and hot applications have been suggested as therapy. Surgical interference does not appear warranted except to drain the relatively infre-

hard swelling in his left cheek. During the day the swelling progressed and eventually extended from the right midcervical region to behind the left ear, and from the angle of the jaw to the clavicle. For two weeks the mass showed variations in size from day to day. Constant hot wet dressings were applied. On Feb. 16 the swelling extended from the right mandibular angle to behind the left ear. He was then seen by Dr. G. Shambaugh who made the following note: "Infiltration finger thick on lateral wall of pharynx on left side behind the posterior pillar and projecting into aural pharynx was incised. This seemed tough and was followed only by a little bleeding." He was then sent into the hospital where examination revealed a very hard, red, swollen mass extending from below left ear to midcervical region and from mandible to clavicle. There was no fluctuation and only slight tenderness in two spots below angle of the jaw. Motion of the head was limited and the jaw could not open more than $\frac{1}{4}$ inch. His temperature was normal and remained so during his hospital stay except for a rise to 99.6° after an abscess was incised. His leucocyte count was 11,800, and differential count normal. On Feb. 19, Dr. Gatewood incised a small abscess beneath the level of the platysma 1 inch below the mandible. Cultures of this showed a moderately hemolytic streptococcus. He remained in the hospital three weeks and was under observation three weeks longer, at which time the induration had almost disappeared, the color of the skin was normal, and the skin no longer fused to the underlying fascia.

CASE 5.—H. L., a man 45 years of age, entered the Presbyterian Hospital on the service of Dr. H. Baker on Sept. 14, 1925. He stated that ten days previously he noted pain and swelling of the left side of his neck. It had increased in size since then. Abscessed teeth had been extracted four months before. His temperature was normal for two days after admission when, after incision, it rose to 102°. It then fluctuated about 100° until the time of his hospital discharge three weeks later. Sept. 15 an incision was made from the tip of the mastoid down to the middle of the sternomastoid muscle. "The skin was red and adherent, and was dissected away from the underlying fascia with difficulty. There was marked infiltration of the tissues in this region. No glands were seen. A small amount of pus was found below the sternomastoid muscle. A section of fascia was taken for histologic examination." Cultures of the pus showed pure growth of *Staphylococcus aureus*. The histologic report showed "numerous newly-formed blood vessels, all engorged, many fibroblasts and numerous round cells. There is extensive proliferation of connective tissue, and, in places, areas of necrosis and suppuration."

The next day there was enormous swelling and edema about the left tonsillar fossa so that the patient had trouble in breathing. Small incisions were made in this region, which relieved the edema but failed to reveal pus. Hot moist dressings were maintained for three weeks, at the end of which time the patient left the hospital. He had an irregular, low fever up to the time of his discharge.

CASE 6.—Mrs. A. L., aged 30 years, entered the Presbyterian Hospital on the service of Dr. Vernon David, Nov. 18, 1932. In December, 1931, she had had a head cold. About the first week in January, 1932, she noted a lump just above the clavicle on the right side. It grew slowly and was painless. She had a period of fever in the middle of January and on Jan. 28 the mass was incised and two ounces of pus were evacuated. She began x-ray treatments in March, when the mass again began to increase in size. It was also incised and drained, but very little pus was obtained. After one x-ray treatment there was a tremendous reaction, with swelling of the neck and face and a temperature of 103° to 104°. At this time, a biopsy was taken and reported to be an "infectious granuloma." In July she had a period of chills and high fever which subsided, and she was placed on iodide and more x-ray treatments were given. On Nov. 7, a mass behind the sternomastoid began to grow and

Schminke:	Treated case as woody phlegmon, but patient died of coronary thrombus and post mortem showed lesion to be cancer							
Fichtner:	1. Recovered	2 mo.	No surgery	Streptococcus	Not known	M		
	2. Recovered	2 1/2 mo.	Incision of small abscess		Erysipelas 1 mo. before	M	20	
	3. Recovered	2 wk.	No surgery	Staphylococcus	Intestinal disturbance during first year	M	20	
	4. Recovered	2 mo.	No surgery	No culture taken	Intestinal catarrh a few months before	F	21	
	5. Recovered	2 mo. plus	Operation on tonsils	No culture taken	No past history of any significance	F	4	2 1/4
Reclus:	1. Recovered	5 wk. plus	Small abscesses opened	No culture taken		M	40	
	2. Died of apoplexy day of entrance of entrance	3 wk.	None	Diplococci single and in chains		M	50	
	3. Recovered	"Long period"	4- to 5-inch deep incision of abscess by thermocautery	Short gram and bacilli (pseudodiphtheria)		M	80	
	4. Recovered	7 to 8 mo.	3 abscesses incised	Not made		M	59	
	5. Recovered	6 mo. plus	5 small abscesses incised	Hemolytic streptococcus		M	35	
Straus:	J. O. Not known	Case is doubtful	Incised; no abscess	Hemolytic streptococcus	3 wk. after getting barley burr in mouth	M	50	
	A. I. Recovered	30 mo.	Several abscesses	<i>Staphylococcus aureus</i>	Head cold	F	30	
	H. L. Recovered	3 wk. plus	Small abscess; edema of pharynx	Hemolytic streptococcus	Tooth extracted 4 mo. before	M	45	
	C. G. Recovered	9 wk.	Pharynx incised—no abscess; small abscess in neck incised	None made	Influenza 4 wk. before	M	45	
	C. A. C. Recovered	6 wk.	2 small abscesses incised	1, hemolytic staphylococcus; 2, hemolytic streptococcus		M	6	
	C. H. Recovered	8 wk.	Incised; no abscess found	No growth	Squeezed boil in parietal region 1 wk. before	M	50	
	R. S. Recovered	16 wk.			Sore throat 12 days before	F	44	

TABLE I

AUTHOR	OUTCOME	DURATION	SURGERY	CULTURES	FOLLOWED AFTER	SEX	AGE
Capasso:	1. Recovered	3 mo.	Punctured abscess	Staphylococcus	Caries in one molar	M	42
	2. Died	"Several weeks"	Symptoms of cord compression; incision of mass	Lardaceous tissue, no sup- puration	No previous history	M	(Priest)
Suchy:	Recovered	2 mo.	Tracheal compression; abscess drained	Staphylococcus		M	(Soldier)
Powers:	1. Recovered	4 mo.	Small abscesses	<i>Staphylococcus aureus</i> and <i>Staph. albus</i>	Diffuse tender swelling of mouth 1 mo. before	M	52
	2. Still sick after 3 wk.	Not followed	Excision of mass in neck	Inflammatory fibrosis of muscle and fasciae	Infection around left parot- id gland 2 mo. before	M	45
	3. Recovered	5 mo.	Repeated small abscesses	<i>Staphylococcus albus</i> and pseudodiphtheroid	Influenza 3 wk. before	M	47
Krause:	1. Recovered	1½ mo.	Abscess above sternum in- cised	Negative; cultures sterile	No previous illness	F	35
	2. Recovered	2½ mo.	Abscess in abdominal wall incised	Staphylococcus	Weak physique	M	18
Merkel:	Recovered	4 mo.	Incision along border of sternocleidomastoid	Streptococcus	Slaughtering actinomycot- ic animal	M	26
Jeney:	Recovered	"Several weeks"	Incision in right arm	Not mentioned	Fall from horse	M	(Soldier)
Von Boenn- inghausen:	Recovered	"Months"	Incised without benefit	Not stated	Tooth extraction 6 wk. before	F	20
Ashurst:	Recovered	"About 3 months"	Entire lesion excised	No growth; negative cul- tures	No previous history	M	40
De Cortes:	Recovered	5 mo.	Small abscesses	Coccidium forms		M	27
Panzner:	Recovered	4 mo.	Mass incised	No pus		M	25
Kuznetsoff:	Recovered	4 mo.	Mass in right subclavicular space opened	Attenuated Streptococcus	Tonsillitis; pharyngitis 2 days before	M	69
Janson:	Recovered	7 wk.	No surgery	No cultures taken	Ludwig's angina 2 mo. be- fore	F	25
Sick:	Recovered	4 mo.	No surgery	Not stated	Streptococcus angina	F	42
Moreau:	Recovered	3 mo.	No surgery	No pus found; no cultures reported	Pneumonia and mastoiditis 5 yr. before	M	44
Soty:	1. Recovered	Not stated	Repeated punctures	No pus found	Inguinal phlegmon after trauma to heel	M	(Soldier)
	2. Recovered	Not stated	Inflammation of left ab- dominal wall incised	No pus found		F	40 (About)
	3. Recovered	6 wk.	10-inch incision over left tibia	No cultures reported	Hereditary tuberculosis	M	(Soldier)

PENETRATING STAB WOUNDS OF THE ABDOMEN AND STAB WOUNDS OF THE ABDOMINAL WALL

A REVIEW OF 184 CONSECUTIVE CASES

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(From the Surgical Service, Harlem Hospital)

STAB WOUNDS that penetrate the peritoneal cavity demand immediate laparotomy because of the possibility of injury to some abdominal viscus or blood vessel. Relatively little has been written or advised in regard to the management of that large group of cases where a person has been stabbed, and penetration of the parietal peritoneum may be suspected at the time of initial hospital examination, but no gross evidence of entry into the abdominal cavity is present. In this type of case to delay and wait, in some instances for the development of clinical signs and symptoms, is to invite disaster. It is true that in the majority of cases at the time of the admission of the patient to the hospital there is adequate clinical proof of intra-abdominal injury. The borderline group of cases, however, has caused us our greatest anxiety. As to operation, there was no fixed rule except the judgment of the surgeon, and at times this devolved upon the more inexperienced members of the staff. Often the decision was extremely difficult.

The purpose of this paper is to present certain statistical data and to attempt a rather critical examination of these data. This seems important because in the literature most studies of these injuries consider gunshot wounds of the abdomen and penetrating stab wounds of the abdomen together. This should not be done because there are differences in the management of the two types of cases. They carry an entirely different mortality and in some instances the problem facing the surgeon is different. In gunshot wounds of the abdomen, if there is no injury of a hollow viscus, the problem of infection is absent or negligible, while in stab wounds of the abdomen without damage to an abdominal viscus, the question of infection, as carried by the knife blade, is always a possibility that may prove to be important.

Stab wounds of the abdominal parietes may be divided into: (1) Stab wounds of the abdomen. The recorded unrevised mortality for these cases is between 20 and 25 per cent, while the reported revised mortality is around 33 per cent. (2) Stab wounds of the abdominal wall. The mortality for these cases is either low or absent.

McGowan in 1935 analyzed 135 stab wounds from this hospital and found a mortality of 20 per cent. He found in 16 instances there was

quent small abscesses or to relieve respiratory obstruction. Six cases are reported.

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TABLE I
TOTAL NUMBER OF CASES 184

	LIVED	DIED	MORTALITY
Stab wounds of the abdomen	111	19	14.61%
Stab wounds of the abdominal wall	51	3	5.5%
Total mortality for all cases	162	22	13.5%
Revised mortality for penetrating stab wounds			23.6%

TABLE II
AGE, SEX, AND RACE

AGE	DECADE	PENETRATING STAB WOUNDS OF ABDOMEN	STAB WOUNDS OF ABDOMINAL WALL
	1-10	0	0
	11-20	7	4
	21-30	56	31
	31-40	43	12
	41-50	18	6
	51-60	5	1
	61-70	1	0
Total number of cases		130	54
SEX	MALE	107	34
	FEMALE	23	20
Total number of cases		130	54
RACE	WHITE	18	4
	COLORED	112	50
Total number of cases		130	54

TABLE III
INJURIES TO ABDOMINAL VISCERA

ORGAN	NUMBER OF CASES
Liver	23
Diaphragm	7
Liver and diaphragm	3
Gall bladder	3
Spleen	4
Stomach {Perforating	6
{Serosal	6
Omentum	5
Mesentery	10
Small intestine {Perforating	13
{Serosal	5
Large intestine {Perforating	9
{Serosal	9
Kidney	3
EVISCERATIONS	
Omentum	29
Small intestine	13
Colon	4
Stomach	1
Retroperitoneal hematoma	6
Hemorrhage into abdomen from abdominal wall with marked blood loss	2

penetration of the parietal peritoneum but no visceral injury, which gave a revised mortality of 33 per cent. Jennings, who discussed McGowan's paper, discovered a mortality of 33 per cent in 16 cases from the Cumberland Hospital and stated "a number of cases [6 or 7] of stab wounds of the abdominal wall had been conservatively treated without opening the abdomen and all recovered."

The material on which this report is based is outlined in Table I.

There were 24 instances in which there was abdominal penetration without visceral injury, and this gives a revised mortality of 23 per cent.

In Table II these cases are listed according to age, race, and sex.

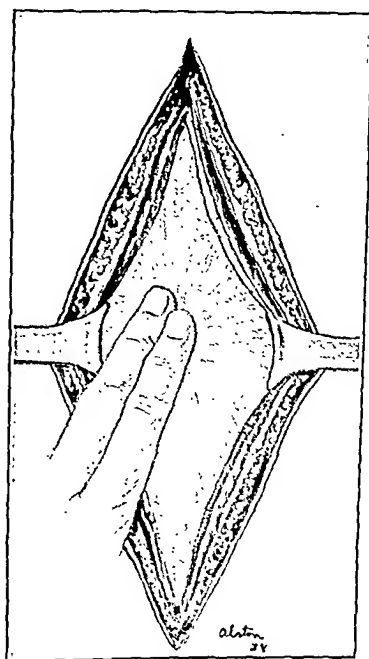


Fig. 1.

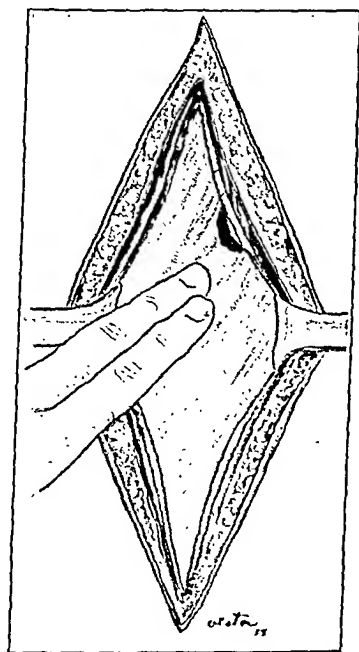


Fig. 2.

Fig. 1.—Pushing the peritoneum away from the rest of the abdominal wall. No rent of peritoneum in this case.

Fig. 2.—Penetration of the parietal peritoneum is noted while peeling it away from the other tissues of the abdominal wall.

All penetrating stab wounds of the abdomen are included in Table V.

In previous years it was the custom to wait and attempt clinically to tell whether penetration of the abdomen was present or not. This was felt to be wrong, and it was therefore decided to operate upon every case of stab wound in the following fashion: To open the abdominal wall down to the peritoneum without opening the peritoneal cavity, and, if there was no sign of penetration of the parietal peritoneum, the operator would gently peel the peritoneum away (Figs. 1 and 2) from the abdominal parietes and look for (a) intraperitoneal hemorrhage and

TABLE V
PENETRATING STAB WOUNDS OF ABDOMEN

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
1	62069	R. T.	25	W	M	2		Evisceration of small intestines	Lived	1/ 2/36
2	62225	W. T.	37	C	M	12	17	Small laceration of small intestine	Lived	1/ 7/36
3	62027	W. H.	28	C	M	3	25	Evisceration of small intestine; through-and-through perforation sigmoid	Lived	1/ 1/36
4	63182	C. Y.	36	C	M	4	13	Superficial laceration of liver	Lived	2/ 3/36
5	64477	J. H.	30	C	M	4	14	No visceral injury	Lived	3/ 1/36
6	65182	R. H.	22	C	M	4½	17	Laceration of dome of diaphragm; sutured	Lived	3/18/36
7	65133	W. K.	52	C	M	2	25	No visceral injury	Lived	3/16/36
8	65658	F. R.	25	C	F	9	13	Peritoneal hematoma, laceration of ileum	Lived	3/29/36
9	65763	W. G.	36	W	M	2	2	Laceration of liver; stab wound of heart	Died	4/ 1/36
10	65986	L. H.	37	W	M	4½	12	No visceral injury	Lived	4/ 6/36
11	66334	P. H.					2	Perforated ileum and sigmoid	Died	4/14/36
12	66552	W. T.	19	C	M	1½	18	Evisceration of omentum, laceration of stomach, colon, ileum, 500 c.c. blood	Lived	4/19/36
13	66790	L. P.	29	C	M	2	14	No visceral injury	Lived	4/25/36
14	66880	C. R.					1	Laceration of spleen, stomach, and diaphragm	Died	4/27/36
15	66314	C. D.	42	C	M	5	16	Laceration of liver	Lived	6/ 8/36
16	69418	J. G.	21	W	M	3	21	Evisceration of small intestine; laceration of gastrotic vessel with hematoma	Lived	6/26/36
17	67949	H. V.	30	C	M	1½	21	Evisceration of small intestine	Lived	6/25/36

TABLE IV
QUADRANT SITES OF STAB WOUNDS*

<i>Anterior:</i>	
Right costal margin	10
Left costal margin	15
Right upper quadrant	25
Epigastrium	22
Left upper quadrant	47
Right lower quadrant	11
Left lower quadrant	41
Paraumbilical region	17
<i>Posterior:</i>	
Right flank	5
Left flank	12

*The disparity between the total number of cases (184) and the above-listed number of stab wounds (205) is due to the fact that in some of the cases two or more stab wounds of the abdominal wall, penetrating or nonpenetrating, were found.

(b) if there was evidence of penetration of the peritoneum. It is needless to state that if the peritoneum has been entered the patient should have a thorough surgical exploration. The skin incision was made closely adjacent to the stab wound itself and in some instances the stab wound was made part of the incision. It was assumed that in all of these cases, if the knife entered the peritoneal cavity, the abdominal cavity was infected and therefore it was safe for the surgeon to investigate. In the event it was found that the abdominal cavity had not been opened, the muscles of the abdominal wall were closed in the usual fashion and one or two Penrose drains were inserted down to the peritoneum. Following this procedure, our total mortality was reduced for all types of cases.

In this way the total mortality of penetrating stab wounds of the abdomen was lowered because in no instance was penetration missed or operation delayed while waiting for symptoms to develop.

As shown in Table VI, there was not a single death where the peritoneal cavity was not entered, while in Table VII, where the peritoneal cavity was entered, although no abdominal viscus was injured, the mortality was 9.67 per cent. The only site where this procedure caused technical difficulties was along the anterior costal margins and in the back.

Our plan of management at Harlem Hospital is to examine clinically each case immediately upon admission and, if the patient is in shock, to administer intravenous fluids by the slow drip method. The flat x-ray film of the abdomen and chest is made while the patient is on the way from the admitting office to the ward. Chest x-rays are necessary because in many instances it is impossible to determine whether the patient has a wound of the abdomen or of the chest. The flat x-ray of the abdomen may show presence of a pneumoperitoneum which, of course, would indicate perforation of some segment of the gastrointes-

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
38	79067	R. M.	31	C	M	4½	6	Perforation of je- junum; laceration of mesentery	Died	1/ 3/37
39	79276	W. H.	22	C	M	1	42	Perforation of je- junum with evis- ceration of jeju- num; mild shock, wound infection	Lived	2/ 4/37
40	79292	H. N.	26	C	M	7½	32	Laceration of mesentery	Lived	2/ 3/37
41	79813	A. S.	24	C	M	9	17	Subserosal hema- toma of colon	Lived	2/16/37
42	79893	B. A.	25	C	M	2	48	Penetrating stab wound of liver; 300 c.c. blood; localized abscess	Lived	2/18/37
43	80259	H. B.	18	C	M	2½	26	Evisceration of omentum	Lived	2/25/37
44	80409	S. M.	47	M	W	2½	1	Penetrating stab wound of ileum, colon, spleen; evisceration of omentum; sple- nectomy	Died	2/27/37
45	81902	J. L.	60	C	M	2½	6	Laceration of liver; postopera- tive pneumonia; hypostatic heart disease.	Died	4/ 3/37
46	81491	C. P.	26	C	M	3	17	No visceral injury	Lived	3/24/37
47	81338	G. M.	44	W	M	1½	33	Penetrating stab wound of omen- tum; hemotho- rax; postopera- tive shock	Lived	3/21/37
48	82127	R. M.	27	C	F	6½	22	Laceration of omentum; atelec- tasis of left lung; shock; 500 c.c. blood.	Lived	4/ 8/37
49	83074	H. H.	26	C	F	3	14	Laceration of gas- tric serosa	Lived	4/29/37
50	82862	E. B.	25	C	F	4½	22	Laceration of liver	Lived	4/26/37
51	83316	H. G.	35	W	M	3½	15	Stab wound of dia- phragm	Lived	5/ 5/37

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
18	69885	V. J.	24	C	F	4	36	Laceration of de- scending colon and ileum; fecal fistula	Lived	7/ 6/36
19	70383	A. F.	41	C	F	24	16	Evisceration of small intestine; uneventful	Lived	7/16/36
20	69862	J. W.	21	C	M	9	3	Laceration of stomach and spleen; splenec- tomy	Died	7/ 6/36
21	28705	J. M.	56	C	M	2	13	No visceral injury	Lived	1/ 6/36
22	72142	W. J.	30	C	M	1½	16	Evisceration of small intestine; perforated ileum	Lived	8/24/36
23	71687	W. W.	34	C	M	2½	15	Evisceration of omentum	Lived	8/14/36
24	71412	P. C.	25	C	F	3	11	No visceral injury	Lived	8/ 9/35
25	72851	R. W.	24	C	M	3½	14	No visceral injury	Lived	9/ 8/36
26	73106	T. N.	21	C	M	2	12	No visceral injury	Lived	9/13/36
27	73259	W. B.	43	C	M	2½	23	No visceral injury	Lived	9/17/36
28	74241	D. T.	22	C	M	3¾	15	No visceral injury	Lived	10/13/36
29	74698	R. L.	29	C	M	1½	15	No visceral injury	Lived	10/27/36
30	74953	J. M.	35	W	M	11½	6	Stab wound of the stomach	Died	11/ 2/36
31	76335	R. Q.	19	C	M	7	19	Lacerated jejunum	Lived	12/ 3/36
32	76539	H. W.	25	C	M	2	21	Perforation of colon	Lived	12/ 4/36
33	76761	C. F.	30	C	F	4	15	No visceral injury	Lived	12/12/36
34	77055	J. M.	17	C	M	3½	10	Laceration of stomach	Lived	12/18/36
35	77695	P. A.	36	C	M	4	2	Laceration of liver 200 c.c. blood	Died	12/31/36
36	78462	R. B.	21	C	M	2¾	17	Evisceration of omentum; mild shock for serosa of colon	Lived	1/17/37
37	78817	E. S.	34	C	M	4	30	Laceration of mes- entery, stomach, serosa, liver; evis- ceration of stom- ach and omentum	Lived	1/24/37

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
68	86709	H. G.	36	C	M	2½	24	Laceration of mesocolon	Lived	8/19/37
69	86437	C. C.	30	C	M	2	29	Laceration of liver, moderate amount of free blood	Lived	8/12/37
70	87406	J. S.	28	W	M	3½	14	Evisceration of omentum	Lived	9/ 5/37
71	86056	P. D.	46	W	M	3	13	Perforation of jejunum	Lived	9/ 7/36
72	88291	T. J.	33	C	M	3	1	Laceration of gastrocolic omentum; obesity; death due to loss of blood; no laceration of viscus	Died	9/26/37
73	88191	A. F.	17	C	F	2	37	No visceral injury	Lived	9/24/37
74	88167	F. W.	32	C	M	4½	18	Laceration of liver, perforation of diaphragm	Lived	9/23/37
75	87885	M. J.	34	C	F	5	18	No visceral injury	Lived	9/16/37
76	87827	A. S.	25	W	M	6½	23	No visceral injury	Lived	10/25/37
77	88571	J. J.	36	C	M	1½	11	Evisceration of omentum	Lived	10/ 3/37
78	88596	L. W.	39	C	M	1	3	Evisceration of omentum and colon; shock; perforated ascending colon	Died	10/ 7/37
79	89425	J. W.	27	C	M	3	21	No visceral injury	Lived	10/21/37
80	89758	J. D.	36	W	M	6	14	Evisceration of omentum and laceration of omentum; 300 c.c. of blood	Lived	10/28/37
81	89930	J. T.	53	W	M	2½	25	Laceration of liver with perforation of diaphragm; 300 c.c. of blood	Lived	10/31/37
82	89932	M. W.	26	W	M	5	14	No visceral injury	Lived	10/31/37
83	91003	G. Y.	23	C	F	4	15	Laceration of omentum	Lived	11/22/37

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
52	S3945	J. H.	38	C	M	6	28	No visceral injury	Lived	5/22/37
53	S3684	J. S.	25	C	M	2½	29	Laceration of dia- phragm; tense pneumothorax (combined wound on chest wall)	Lived	5/13/37
54	S4967	M. C.	32	C	M	6	11	No visceral injury	Lived	6/30/37
55	S4759	J. M.	49	C	M	5	23	No visceral injury	Lived	6/22/37
56	S4378	R. W.	22	C	M	4	13	Evisceration of omentum	Lived	6/ 7/37
57	S4133	U. C. M.	30	C	M	1	1	Evisceration of small intestines and colon; laceration of mesocolon and large bowel	Died	5/29/37
58	S5113	J. O.	49	C	M	12	3	Evisceration of colon and laceration of the liver	Died	7/ 4/37
59	S5354	H. A.	27	C	M	5	18	Laceration of colon and serosa	Lived	7/12/37
60	S5171	D. R.	29	C	F	2	22	Perforation of je- junum in three places; postop- erative pneu- monia; shock	Lived	7/ 6/37
61	S5133	J. L.	27	C	M	3	1	Evisceration of je- junum and omen- tum, perforation of jejunum, lac- eration of liver and gall bladder	Died	7/ 5/37
62	S5729	E. S.	28	C	M	2	22	Laceration of liver	Lived	7/22/37
63	S5684	L. T.	39	C	M	4	24	No visceral injury	Lived	7/21/37
64	S5906	F. D.	37	W	M	1	2	Evisceration of je- junum; complete section of small intestines; perfo- ration of small intestines; shock	Died	8/27/37
65	S6430	J. T.	36	C	F	5¾	12	No visceral injury	Lived	8/11/37
66	S6983	W. H.	21	C	M	3	18	Laceration of liver, free blood	Lived	8/26/37
67	S6982	W. H.	29	C	M	2½	18	Evisceration of omentum	Lived	8/26/37

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
68	86709	H. G.	36	C	M	2½	24	Laceration of mesocolon	Lived	8/19/37
69	86437	C. C.	30	C	M	2	29	Laceration of liver, moderate amount of free blood	Lived	8/12/37
70	87406	J. S.	28	W	M	3½	14	Evisceration of omentum	Lived	9/ 5/37
71	86056	P. D.	46	W	M	3	13	Perforation of jejunum	Lived	9/ 7/36
72	88291	T. J.	33	C	M	3	1	Laceration of gas- trocolic omentum; obesity; death due to loss of blood; no laceration of viscus	Died	9/26/37
73	88191	A. F.	17	C	F	2	37	No visceral injury	Lived	9/24/37
74	88167	F. W.	32	C	M	4½	18	Laceration of liver, perforation of diaphragm	Lived	9/23/37
75	87885	M. J.	34	C	F	5	18	No visceral injury	Lived	9/16/37
76	87827	A. S.	25	W	M	6½	23	No visceral injury	Lived	10/25/37
77	88571	J. J.	36	C	M	1½	11	Evisceration of omentum	Lived	10/ 3/37
78	88596	L. W.	39	C	M	1	3	Evisceration of omentum and colon; shock; perforated ascending colon	Died	10/ 7/37
79	89425	J. W.	27	C	M	3	21	No visceral injury	Lived	10/21/37
80	89758	J. D.	36	W	M	6	14	Evisceration of omentum and laceration of omentum; 300 c.c. of blood	Lived	10/28/37
81	89930	J. T.	53	W	M	2½	25	Laceration of liver with perforation of diaphragm; 300 c.c. of blood	Lived	10/31/37
82	89932	M. W.	26	W	M	5	14	No visceral injury	Lived	10/31/37
83	91003	G. Y.	23	C	F	4	15	Laceration of omentum	Lived	11/22/37

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
84	90500	R. F.	40	C	M	6	2	Evisceration of omentum	Died	11/12/37
85	90593	R. S.	45	C	M	5½	4	Perforation of small intestines and mesentery; 1,500 c.c. free blood; shock	Died	11/14/37
86	90482	A. W.	39	C	M	2½	18	Laceration of liver	Lived	11/12/37
87	90185	C. C.			M		35	Laceration of liver with perforation of diaphragm	Lived	11/ 6/37
88	92372	A. P.	52	C	M	3½	20	No visceral injury	Lived	12/22/37
89	92321	A. T.	22	C	M	4	12	Evisceration of omentum; perforation of ileum	Lived	12/20/37
90	92314	B. R.	24	C	F	2	16	Retroperitoneal hematoma anterior wound through postperitoneum	Lived	12/20/37
91	92003	C. C.	44	C	M	2½	30	Laceration of liver	Lived	12/14/37
92	92206	P. G.	53	W	M	5	20	Laceration of mesentery right hemothorax; no free blood	Lived	12/18/37
93	91811	C. W.	24	C	F	2½	40	Retroperitoneal hematoma (40 days due to arm injury)	Lived	12/10/37
94	91923	M. M.	23	C	F	8½	16	Laceration of liver; 150 c.c. of blood	Lived	12/12/37
95	93083	M. B.	39	C	F	3¼	13	Laceration of liver	Lived	1/ 6/38
96	93216	J. W.	42	C	M	2½	15	Laceration of colon; evisceration of omentum	Lived	1/ 8/38
97	93721	B. J.	42	C	M	3	16	No visceral injury	Lived	1/18/38
98	94299	M. E. M.	19	C	F	3½	10	Abdominal cavity filled with blood	Lived	1/31/38
99	94793	M. M.	22	C	F	2	15	Perforated ileum; 300 c.c. blood	Lived	2/ 9/38
100	86330	M. B.	23	C	F	2½	22	Deep epigastric artery; abdomen filled with blood	Lived	2/28/38

TABLE V—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
101	97031	W. H.	29	C	M	14	18	Perforated stom- ach and meso- colon; 500 c.c. blood	Lived	3/28/38
102	64736	A. B.	38	C	M	4½	15	Penetrating stab wound of left lobe, liver, mod- erate blood	Lived	3/ 9/36
103	67653	A. P.	28	C	M	3½	27	Laceration of liver	Lived	5/15/36
104	69401	J. N.	29	C	F	1½	17	Evisceration of omentum	Lived	6/25/36
105	71628	M. R.	24	C	F	12	17	Laceration of epi- gastric artery	Lived	8/13/36
106	59207	L. H.	37	C	M	4	10	Laceration of dia- phragm; lacera- tion of colon	Lived	11/ 6/35
107	74888	J. R.	29	C	M	3	32	Evisceration of omentum	Lived	8/21/36
108	77740	S. M.	36	C	M	8½	31	Laceration of dia- phragm with evis- ceration of omen- tum	Lived	12/31/36
109	80576	Y. Y.	43	C	M	4	15	No visceral injury	Lived	3/ 3/37
110	91206	A. B.	31	C	M	2¾	18	No visceral in- jury; pelvis full of blood; retro- peritoneal hema- toma	Lived	8/31/37
111	98464	J. B.	41	W	M	1	143	Evisceration of omentum; com- plete section of transverse colon; laceration of ter- minal ileum; shock	Lived	4/25/38
112	98409	M. T.	32	C	F	6	13	No visceral injury	Lived	4/23/38
113	93863	C. W.	24	C	M	5	45	Lacerated kidney; through-a n d- through lacerated liver 500 c.c. blood in abdo- men; shock; kid- ney repaired; ab- domen opened; liver packed; Sprengel inci- sion; pneumonia; secondary opera- tion; acute intes- tinal obstruction	Lived	1/17/38

TABLE V—CONT'D

SERIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
114	98030	L. C.	38	C	M	2	21	Evisceration of omentum	Lived	4/16/38
115	97471	H. S.	44	Jap	M	3	18	Evisceration of omentum; hema- toma of colon	Lived	4/ 5/38
116	97229	E. A.	38	C	M	1	26	Evisceration of small intestine; perforated stom- ach and colon; 400 c.c. blood; shock	Lived	4/ 1/38
117	96472	C. S.	38	C	M	4½	51	Retroperitoneal h e m a t o m a; wound infection	Lived	3/17/38
118	96994	C. M.	17	C	M	2¾	18	Lacerated spleen, very little free blood in perito- neum; splenecto- my	Lived	8/26/37
119	10147	J. J.	26	C	M	3½	24	Three perforations in small intes- tine; no hemor- rhage	Lived	6/22/38
120	103349	C. R.	37	C	M	2	18	Small perforated fundus in gall bladder; chole- cystostomy	Lived	7/27/38
121	104687	C. R. D.	28	C	M	2½	12	Laceration of liver; 100 c.c. free blood	Lived	8/28/38
122	105793	C. W.	28	C	M	6	23	Evisceration of omentum; 100 c.c. blood; lacer- ation of spermatic artery	Lived	9/12/38
123	107439	J. E.	26	C	M	8	19	Lacerated liver, little free blood	Lived	10/15/38
124	108218	G. B.	21	C	F	7	13	Evisceration of omentum	Lived	10/31/38
125	108070	R. W.	32	C	F	4	15	Evisceration of omentum	Lived	10/27/38
126	108460	H. P.	21	C	M	2½	13	No visceral injury or bleeding	Lived	11/ 4/38

TABLE V—CONT'D

SERIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL POST- OPERA- TIVE- LY	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
127	106363	G. P.	25	C	F	4	13	Evisceration of omentum	Lived	9/23/38
128		W. R.	22	C	M	2½		Evisceration of omentum	Lived	9/23/38
129	103111	P. K.	30	W	M	2	3	Through-and-through stab wound of liver; perforation of two small intestines	Died	7/23/38
130	103508	A. J.	31	C	M	2½	2	Two perforations of terminal ileum; evisceration of omentum; 100 c.c. blood in abdomen	Died	7/30/38
Total number of cases									130	
Total number of patients that lived									111	
Total number of patients that died									19	
Mortality									17.3%	
Total number of cases with no visceral injury									29	
Average time in hospital before operation, 3 hours, 45 minutes										

TABLE VI

STAB WOUNDS OF THE ABDOMINAL WALL (PERITONEUM NOT OPENED AT OPERATION)

SERIES CASE NO.	HOSPITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME IN HOSPITAL BEFORE OPERATION IN HOURS	DAYS IN HOSPITAL BEFORE OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
1	65611	O. L.	34	C	F	5½	11	Lived	3/28/36
2	70770	C. T.	23	C	M	6½	7	Lived	7/23/36
3	75887	M. F.	20	C	F	7½	11	Lived	11/24/36
4	76087	K. T.	20	C	M	4	12	Lived	11/27/36
5	77656	R. M.	31	C	F	7	12	Lived	12/30/36
6	80267	F. D.	42	C	M	2	8	Lived	2/25/37
7	80508	R. S.	28	C	F	3½	8	Lived	3/ 2/37
8	83090	M. S.	21	C	F	4½	9	Lived	4/29/37
9	83610	J. S.	50	C	M	3½	16	Lived	5/11/37
10	84059	W. S.	37	C	M	3	16	Lived	5/26/37
11	85077	M. B.	27	C	M	3½	10	Lived	7/ 3/37
12	87543	L. J.	26	C	F	6	10	Lived	9/ 9/37
13	90119	J. S.	22	W	M	11½	11	Lived	11/ 5/37
14	92430	C. T.	23	C	F	4¾	14	Lived	12/23/37
15	94133	W. S.	48	C	M	2½	13	Lived	1/27/38
16	94316	W. W.	20	C	M	4	11	Lived	1/31/38
17	95298	J. S.	31	C	M	4½	13	Lived	2/21/38
18	66093	H. L.	25	C	M	6½	10	Lived	4/ 8/38
19	98252	Q. S.	22	C	F	10½	10	Lived	4/20/38
20	103464	J. S.	36	C	M	2	24	Lived	7/29/38
21	101850	E. C.	16	C	F	2½	12	Lived	7/ 1/38
22	103007	J. W.	15	C	M	3	7	Lived	7/21/38
23	106462	J. O.	22	W	M	4	7	Lived	9/25/38

Total number of cases 23
 Total number of deaths 0
 Total number of patients who lived 23
 Average time in hospital before operation, 4 hours, 55 minutes
 Average number of days in hospital 11.7
 Mortality 0

TABLE VII

STAB WOUNDS OF THE ABDOMINAL WALL (PERITONEAL CAVITY EXPLORED)

SERIES CASE NO.	HOSPITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME IN HOSPITAL BEFORE OPERATION IN HOURS	DAYS IN HOSPITAL BEFORE OPERATION	LIVED OR DIED	DATE OF DIS- CHARGE
1	62620	H. J.	33	C	M	5	14	Lived	1/20/36
2	63129	J. W.	21	C	F	1½	11	Lived	2/ 2/36 (AOR)
3	63508	A. P.	21	W	M	3	11	Lived	2/11/36
4	66584	L. S.	31	C	M	3	2	Died	4/20/36
5	68953	W. S.	35	C	M	4	41	Lived	6/15/38
6	68836	F. G.	13	W	M	3½	15	Lived	6/13/36
7	69401	J. N.	29	C	F	1¼	17	Lived	6/25/36
8	69889	W. M.	18	C	M	3	14	Lived	7/ 6/36
9	70761	W. M.	27	C	M	2¾	15	Lived	7/23/36
10	71980	D. J.	42	C	M	5	12	Lived	8/20/36
11	74404	L. H.	30	C	F	6	14	Lived	10/18/36
12	78460	F. A.	38	C	M	2	23	Lived	1/18/37
13	79833	C. D.	23	C	M	3	13	Lived	7/12/37
14	80291	P. M.	20	C	M	3½	11	Lived	2/25/37
15	81046	S. B.	35	C	M	3½	18	Lived	3/15/37
16	85542	S. R.	27	C	M	2	24	Lived	7/14/37
17	85805	W. W.	27	C	M	3	22	Lived	7/23/37
18	86253	N. D.	27	C	F	5	21	Lived	8/ 7/37
19	86967	L. W.	25	C	M	1½	15	Lived	8/25/37
20	90616	W. F.	42	C	M	4	5	Died	11/15/37
21	92462	P. M.	23	C	M	2½	11	Lived	12/24/37
22	92147	W. A.	20	C	M	6	17	Lived	1/17/38
23	92192	J. C.	39	C	M	13	15	Lived	1/ 3/38
24	70270	D. B.	28	C	F	2½	10	Lived	7/24/36
25	83948	A. J.	24	C	F	6	13	Lived	5/22/37
26	92407	S. H.	44	C	F	7½	9	Lived	12/23/37
27	99425	J. S.	45	C	M	2¼	1	Died	5/15/38
28	105290	I. S.		C	F	3	10	Lived	9/ 2/38
29	105874	J. S.	30	C	F	2½	12	Lived	9/14/38
30	101683	R. W.	41	C	F	24	47	Lived	6/27/38
31	102335	J. D.	24	C	M	4	4	Lived	7/10/38
Total number of cases								31	
Total number of deaths								3	
Total number of patients who lived								28	
Average time in hospital before operation, 4 hours, 32 minutes									
Average number of days in hospital of patients who lived								17	
Mortality								9.67%	

tinal tract. As seen from some of the tables, patients often present combined injuries of the chest and abdomen.

The anesthesia used in these cases was open cone ether or nitrous oxide oxygen and ether anesthesia. Under no conditions should spinal anesthesia be used in exploring penetrating stab wounds of the abdomen, because if there is perforation of the intestines, the increased peristalsis adds greatly to the amount of spill of abdominal contents in the abdominal cavity; and also, if there is an intraabdominal hemorrhage of any amount, the low blood pressure contraindicates spinal anesthesia.

Drainage was used in the majority of these cases and we are still of the opinion that these cases should not be sutured without drainage.

TABLE VIII
MORTALITY

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL BE- FORE DEATH	PATHOLOGY FOUND AT OPERATION	CAUSE OF DEATH FROM MEDICAL EXAM- INER'S RECORDS	DATE OF DEATH
9	65763	W. G.	36	W	M	2	2	Shock, tension; pneumothorax	Hemor- rhage and sepsis	4/ 1/38
11	66334	P. H.			M		2	Perforation of ileum and sig- moid colon	Acute suppu- rative perito- nitis	4/14/38
14	66880	C. R.			M		1	Laceration of spleen, stom- ach, and dia- phragm		4/27/38
20	69862	J. W.	21	C	M	9	3	Perforated stomach, spleen, with splenectomy	Acute suppu- rative perito- nitis	7/ 6/36
30	74953	J. M.	35	W	M	11½	6	Perforated stomach	Acute suppu- rative perito- nitis	11/ 2/36
35	77695	P. A.	36	C	M	4	2	Laceration of liver; 200 c.c. blood	Acute suppu- rative perito- nitis and sepsis	12/31/36
61	85133	J. L.	27	C	M	3	1	Evisceration of jejunum and omentum; lac- eration of liver and gall bladder; 750 c.c. blood; died at close of operation		7/ 5/37
58	85113	J. O.	49	C	M	12	3	(Refused op- eration 10 hours.) First operation: Evisceration of colon and omentum; lac- eration of liver Second opera- tion: For hem- orrhage, lac- eration of mesocolon	General- ized perito- nitis; broncho- pneumonia	7/ 4/37

TABLE VIII—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL BE- FORE DEATH	PATHOLOGY FOUND AT OPERATION	CAUSE OF DEATH FROM MEDICAL EXAM- INER'S RECORDS	DATE OF DEATH
57	S4133	A. N.	30	C	M	1	1	Evisceration of small intestine and colon; lac- eration of mesocolon; perforation of colon; shock	Shock and hemor- rhage	5/29/37
45	S1902	J. L.	60	C	M	2½	6	Lacerated liver; postop- erative pneu- monia hypo- static asth- matic heart disease	General- ized peri- tonitis with paralytic ileus, hypo- static; pneu- monia	4/ 3/37
44	S0409	S. M.	47	W	M	2½	1	Stab wound of stomach colon, spleen; evis- ceration of omentum; splenec- tomy; 100 c.c. of blood	Shock hemor- rhage into abdom- inal cavity	2/27/37
38	79067	R. M.	31	C	M	4½	6	Perforated jejunum; no shock; lacera- tion of mesen- tery	Acute suppu- rative peri- tonitis	1/ 3/37
79	S8596	L. W.	39	C	M	1	3	Evisceration of omentum, colon; shock; perforated ascending colon	Acute suppu- rative peri- tonitis	10/ 7/37
86	90953	R. S.	45	C	M	5½	4	Perforated small intestine and mesen- tery; 1,500 c.c. free blood; shock (refused op- eration 5 hours)	Acute suppu- rative peri- tonitis	11/14/37

TABLE VIII—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL BE- FORE DEATH	PATHOLOGY FOUND AT OPERATION	CAUSE OF DEATH FROM MEDICAL EXAM- INER'S RECORDS	DATE OF DEATH
4	66584	L. S.	31	C	M	3	2	Penetrating stab wound of chest; hemothorax and pneumothorax; death likely due to bed injuries; abdomen opened; mediastinal emphysema; no laceration of viscus	Terminal bronchopneumonia	4/20/36
72	88291	T. J.	33	C	M	3	1	Laceration of gastroduodenum; 1,500 c.c. blood; shock; obesity; death due to loss of blood	Hemorrhage and shock	9/26/37
85	90500	R. F.	40	C	M	6	2	Evisceration of omentum; refused operation 4 to 5 hours	Acute suppurative peritonitis; sepsis	11/12/37
20	90616	N. F.	42	C	M	4	5	Nonpenetrating stab wound; peritoneum opened; retroperitoneal hematoma; no free blood; lacerated kidney	Sepsis; acute suppurative peritonitis; bronchopneumonia	11/15/37
64	85906	F. D.	37	W	M	1	2	Evisceration of jejunum; complete section of small intestine; perforated small intestine; 8 inch stab wound of upper abdomen; shock	Generalized peritonitis; hypostatic pneumonia	8/27/37

TABLE VIII—CONT'D

SE- RIES CASE NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPER- ATION IN HOURS	DAYS IN HOS- PITAL BE- FORE DEATH	PATHOLGGY FOUND AT OPERATION	CAUSE OF DEATH FROM MEDICAL EXAM- INER'S RECORDS	DATE OF DEATH
120	99425	J. S.	45	C	M	2¼	1	Shock, post-mortem x-ray showed very large pericardial shadow	Hemo-pericardium	5/15/38
129	103111	P. K.	30	W	M	2	3	Through - and - through stab wound of liver; perforations of two small intestines	Peritonitis	7/23/38
130	103508	A. J.	31	C	M	2½	2	Two perforations of terminal ileum; evisceration of omentum; 100 c.c. blood in omentum	Shock and peritonitis	7/30/38
Total number of deaths									22	
Deaths from peritonitis									11	
Deaths from hemorrhage									6	
Combined abdominal and chest lesions									6	

although we frankly admit the tendency of most surgeons today is not to use drainage. We have seen no harm result from the intelligent use of drainage and we are of the opinion that our mortality has been lowered as the result of its use. A blood bank makes blood instantly available. In the absence of readily available blood, when serious cases are admitted to a hospital, immediate intravenous injection of 50 per cent glucose followed by normal saline solution as a slow drip is indicated.

It is necessary to study and watch the water balance of these patients very closely, so that there will be no postoperative dehydration.

In instances where the knife penetrates the mobile portion of the large bowel, such as the transverse colon and sigmoid, it is our practice to exteriorize that portion of the large bowel, in an effort to lessen the incidence of peritonitis. This we unhesitatingly recommend, as shown by the following case report.

In Table VIII, the details of the mortality are outlined. The cause of death was obtained from the records of the Medical Examiner's Office of New York City, and for this kindness we thank them.

CASE REPORT.—No. 14531, admitted Dec. 4, 1937; adult white male was brought to the hospital suffering from a self-inflicted wound, and on admission several loops of small intestines and omentum were protruding. The laceration of the abdominal

TABLE IX
CASES EXHIBITING SEVERE SHOCK ON ADMISSION

CASE SERIES NO.	HOS- PITAL CASE NO.	INI- TIALS	AGE	RACE	SEX	TIME BE- FORE OPERA- TION IN HOURS	DAYS IN HOS- PITAL, BE- FORE OPERA- TION	PATHOLOGY FOUND AT OPERATION	LIVED OR DIED
8	65658	F. R.	25	C	F	9	13	Retroperitoneal hematoma; two small perforations of ileum; shock; tension pneumothorax of chest	Lived
27	73259	W. B.	43	C	M	2½	23	Shock, likely due to pre-admission; hemorrhage from lacerated tendons	Lived
36	78462	R. B.	21	C	M	2¾	17	Mild shock; evisceration of omentum; lacerated serosa colon	Lived
39	79276	W. H.	22	C	M	1	42	Mild shock; evisceration of jejunum, perforation of jejunum; wound infection	Lived
47	81338	G. N.	44	W	M	1½	23	Evisceration of omentum; hemothorax; postoperative shock	Lived
48	82127	R. M.	27	C	F	6½	22	Shock; 500 c.c. blood in peritoneum; lacerated omentum; atelectasis left lower lobe	Lived
57	84133	U. C. M.	30	C	M	1	1	Shock; evisceration of small intestines and colon; laceration of mesocolon and large bowel	Died
60	85171	D. R.	29	C	F	2	22	Three perforations of jejunum; postoperative lobar pneumonia; shock	Lived
64	85906	F. D.	37	W	M	1	2	Shock; evisceration of jejunum; complete section and perforation of small intestine	Died
72	88291	T. J.	33	C	M	3	1	Laceration of gastrotic omentum; obesity; death due to blood loss; no laceration of viscus	Died
79	88596	L. W.	39	C	M	1	3	Evisceration of omentum and colon; shock; perforated ascending colon	Died
86	90953	R. S.	45	C	M	5½	4	Perforated small intestine and mesentery; 1,500 c.c. blood; shock; refused operation 5 hours	Died
114	93683	C. W.	24	C	M	5	45	Lacerated kidney through-and-through; lacerated liver; 500 c.c. blood; kidney repaired; liver packed; Sprengel incision	Lived
117	97279	E. A.	38	C	M	1	26	Shock; evisceration of small intestine; perforated stomach; 400 c.c. blood	Lived
120	99425	J. S.	45	C	M	2¼	1	Shock; post-mortem x-ray showed very large pericardial shadow	Died

parietes was 5 inches in length below the umbilicus on the right side. Four inches of the terminal ileum, about 12 inches from the cecum, were completely severed from the mesentery and contained three separate incisions. This was excised and a lateral anastomosis with a Murphy button was made. The transverse colon was completely severed and a double barrel colostomy was made. On Feb. 26, the colostomy spur was crushed, and on March 30, the colostomy was closed. The patient went home two weeks later in good condition.

CONCLUSIONS

1. Immediate surgical investigation of all cases of stab wounds of the abdomen and abdominal wall is recommended.
2. Spinal anesthesia should not be used in these cases.
3. These cases require careful preoperative and postoperative care. The use of slow drip blood transfusion in all cases admitted in shock is a most helpful procedure until hemorrhage has been controlled. Water balance should be maintained by means of continuous intravenous glucose or saline drips.

REFERENCES

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SPONTANEOUS HEMATOMA OF THE ABDOMINAL WALL

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ALTHOUGH spontaneous hematoma of the abdominal wall was described by Hippocrates and Galen, the condition is of relatively infrequent occurrence, and little research has been devoted to it until recent years. Many authors have speculated as to its etiology and its predisposing causes, but conclusive evidence is still lacking. Full descriptions of long series of cases serve to clarify these unusual surgical conditions. I add three cases to the published record, two such crises in a single patient, an occurrence which, from a rather exhaustive search of the literature, seems to be unique.

Maydl,¹ in 1882, gave us our first comprehensive discussion of spontaneous hematoma of the abdominal wall, reporting fourteen cases; and the literature since that time has contained an increasing number of articles on the subject, until a considerable number of cases are now on record.

ETIOLOGY

Cullen and Brödel,² in a most comprehensive study of the rectus abdominis muscle, its nerve supply, sheaths and blood vessels, have shown the most probable accidents to it which may occur as a result of previous disease, or in the presence of unusual strain, when the muscle, either partially or in its entirety, is in a state of maximum contraction or relaxation. They believe that most cases are due to (1) the greater frequency with which hyaline degeneration of muscle fibers follows acute infectious diseases in the rectus abdominis than in other muscles of the body; (2) the excessive change in length between maximum contraction and stretching of the lower rectus; (3) the vulnerability of the veins accompanying the inferior epigastric artery; (4) unusual muscular exertion; (5) pregnancy; (6) heart disease; and (7) hemorrhagic disease.

Age was considered a strongly predisposing factor by Block,³ McCarty,⁴ Dencks,⁵ and Krummel,⁶ and most other writers on this subject have believed the age of the patient to be an important factor. Quite as large a group has considered sudden, severe, muscular strain; the sex of the patient; pregnancy; and previous acute, infectious disease, equally important in determining a cause for this emergency. It is interesting to note that cases are recorded in which there was no unusual sudden or severe muscular action, but in which only moderate muscular activity was followed by a hematoma of the abdominal wall. The preponderance of evidence, gathered from a study of the literature, would indicate, however, that in almost every case there have been pres-

ent great muscular strain, advancing age, previous acute infectious disease, or pregnancy, either singly or in combination.

PATHOLOGY

No distinctive pathologic changes are to be seen in these cases, other than those which may be attributed to previous infection or degenerative changes due to age. Cullen and Brödel² observe: "It seems quite clear that Zenker's degeneration of the recti muscles is a not infrequent accompaniment of influenza and influenzal pneumonia and that the muscle fibers become so friable that rupture occurs with varying degrees of hemorrhage." Dencks,⁵ in reporting the results of microscopic examination of the rectus muscles and the epigastric vessels, stated that arteriosclerotic changes which would usually be found in patients of the same age were present, but that in none was there unusual pathologic change.

SYMPTOMATOLOGY

Pain is almost always the primary and most important symptom. It is usually sudden and severe, but at times it is mild and may or may not increase in intensity. Second, there is always a palpable mass, which may vary from one inch to several inches in diameter. The depth of the hematoma in the abdominal wall will determine the size of the mass. If located between the posterior rectus and the peritoneum, a larger proportion will protrude posteriorly, than project anteriorly against the skin. Occasionally there will be hemorrhage of sufficient size to produce marked prostration, with moderate elevation of temperature and leucocytosis. Ecchymosis is considered a most important symptom, but it was not present in any one of my cases. Due to the obscure symptomatology and the number of other conditions simulated, the diagnosis is difficult, unless one has studied the literature on the subject or has seen other cases previously.

Spontaneous hematoma of the abdominal wall has been mistaken for almost every common or uncommon condition of the abdominal cavity and its contents. Acute emergencies as well as chronic diseases have been suspected, such as acute and chronic appendicitis, ovarian cyst and abscess, ectopic pregnancy, intestinal obstruction, acute and chronic cholecystitis, acute pancreatitis, perforated gastric and duodenal ulcer, thrombosis and intussusception, volvulus, degenerating fibroids of the uterus,⁷ calculi of the kidney, ureter, and bladder, and numerous types of malignant and benign growths.

DIAGNOSIS

Diagnosis will depend almost completely upon the clinician's being "hematoma conscious," for he must think immediately of this condition when confronted with a painful mass in the abdomen (abdominal wall), of sudden formation, occurring during pregnancy in an older woman or in a person who has recently had an acute infectious disease. The mass varies in diameter from 1 to 8 inches in the cases reported in

the literature. The crisis is often preceded by a sudden violent muscular effort, such as sneezing, coughing, or during great muscular activity, as in soldiers or acrobats. Robertson⁸ believes the condition may be diagnosed by grasping the mass laterally with both hands and attempting to draw it away from the abdomen. The fact that the tumor is palpable when the rectus muscle is both relaxed and taut is of considerable importance in making a diagnosis.

Since the hematoma points posteriorly between the rectus muscle and the peritoneum, pain from the peritoneal irritation is produced and intra-abdominal masses, new growths, and congenital abnormalities must be excluded.

TREATMENT

Immediate diagnosis and operation for removal of all clotted blood, ligation of all ruptured vessels, and suture of the torn muscle constitute the undoubted treatment of choice. The advisability of providing for drainage will depend on the extent of the hemorrhage and the opinion of the individual surgeon. Operative mortality in this condition has been very low and prompt surgical attention with supportive treatment, when necessary, should yield satisfactory results.

In the case of a small hematoma causing only mild discomfort, it may be permissible to delay operation, as was done in one of my cases; but even here the possibility of suppuration is so great that immediate operation is advocated by a majority of the surgeons treating this condition.

CASE REPORTS

The reports given here include one case, that of a white housewife, 57 years of age, in whom the condition occurred once; and the other, a white housewife in whom this emergency occurred first at the age of 36 years and again at the age of 41 years. This recurrence is interesting since no other such instance has been discovered in the literature.

CASE 1.—A white housewife, 57 years of age, suffering from a cough of several days' duration, complained of mild soreness in the left upper abdomen which was emphasized by coughing. She had been awakened about one hour after retiring and had discovered a mass in the upper left rectus at the site of the pain from which she had suffered for the previous three or four days. The patient was 5 feet, 2 inches tall and weighed 185 pounds, with a systolic blood pressure of 158 and diastolic pressure of 60. When examined about an hour after the condition was first noted, the mass was about 1½ inches in diameter. Since it was not very painful or tender, it was allowed to remain in situ and was completely absorbed in about four weeks.

CASE 2.—In February, 1935, a white housewife 36 years of age, while walking in the street, coughed violently and immediately felt a sharp pain in the lower right abdomen. The pain was so severe that she had to be carried to her home in an automobile. When examined about two hours later, a mass was discovered in the site of an old right rectus incision about one inch below the umbilicus. The mass measured about 2 by 3 inches and was very tender, with moderate rigidity in this area. Temperature was 99.3°; pulse, 104; blood pressure, 118/78; R.B.C., 3,590,000;

hemoglobin, 80 per cent; W.B.C., 8,000; polynuclears, 65 per cent; coagulation time was normal. There was no nausea or vomiting and no distention of the abdomen. A friend, a professor of surgery in a Southern medical school, was visiting me at the time and was asked to examine the patient. A tentative diagnosis of ovarian cyst was made. At operation, four days later, a midline incision revealed the presence of blood, posterior to the rectus, which had extravasated to the midline. The peritoneum was not opened. About six ounces of clotted blood were removed and the rectus muscle was sutured. The wound was closed and a Penrose drain was inserted through a stab wound over the lower border of the original mass. Recovery was uneventful. Five years later, lacking one month, the same patient, while coughing violently about 4 A.M., felt a similar pain, sudden and severe, in the lower, left abdomen. Having seen a similar case since this patient's original attack and having read increasingly numerous discussions of the subject in the medical literature, the origin of the mass was recognized at once. It was located in the left rectus muscle; formation was sudden following violent coughing. At operation, a horizontal incision was made, about two inches in length, just over the mass; the clotted blood was evacuated; several bleeding points were ligated; the torn muscle was sutured and the incision was closed with a cigarette drain, which was left in place for forty-eight hours. The patient left the hospital in four days, following warnings to avoid violent coughing in the future.

SUMMARY

When subjected to great strain by violent contraction of its upper portion, pathologic changes in the lower third of the rectus abdominis muscle cause tearing of the inferior epigastric artery, due to its vulnerable position.

Pulmonary conditions producing coughs of a violent nature constitute one of the most common causes of spontaneous hematoma of the abdominal wall.

Other factors of major importance in the etiology of this condition are increased age, pregnancy, and violent muscular activity.

It is possible that further studies in the chemistry of the blood and in avitaminosis may throw more light on the cause of such accidents to muscles and blood vessels.

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MUSCLE FLAP REPAIR OF PERFORATIONS IN THE LARGER ARTERIES OF DOGS

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THE MODERN methods of blood vessel surgery originated in 1899, when Dorfler's experiments¹ demonstrated the value of using fine silk, small round needles, and a continuous suture embracing all coats of the injured vessel wall. These principles were later incorporated in the well-known procedure introduced by Carrel² in 1902. Watts³ also used this technique successfully in thirteen circular anastomoses of the carotid artery without the development of thrombosis. Microscopic examination of the suture lines, twenty-eight to eighty-two days after operation, showed gradual restoration of all elements of the arterial wall except the inner elastic membrane.

In 1911, Dorfler's results were extensively confirmed by Guthrie,⁴ who accomplished surgical repair of many different types of experimental vascular injury. One method described by Guthrie was the application of a "patch." It consisted of a segment of vein wall sutured over the opening in the injured vessel in instances in which patency of the lumen was jeopardized. This complicated and difficult procedure was said to be indicated where simple suture might lead to constriction of the lumen because portions of the vessel wall were actually missing or had to be removed.

In 1914, Horsley⁵ reported that rapid hemostatic effects followed the application of detached muscle fragments to the cut surface of the brain, liver, and other soft tissues. By microscopic examination, he observed the presence of blood platelets and fibrin fibrils in the plane of contact, within a few minutes, and commented as follows on the strength of the fibrinous adhesion formed between the two surfaces: "Such adhesion is necessarily limited by the pressure at which the blood is escaping from the bleeding point. By direct experiments on divided arteries (including the aorta) in the cat and dog, I found that a muscle fragment hemostasis would resist as much as 60 to 80 mm. of mercury blood pressure."

Thrombokinesis, adhesiveness, and asepticity were regarded by Horsley as important properties of muscle fragments in the control of hemorrhage. Horsley compared this thrombokinetie action of detached muscle to results first described by Wooldridge⁶ in which the addition of tissue juices to blood accelerated its coagulation. Risley⁷ also observed that

muscle fragments readily unite to bleeding surfaces to which they are sutured and form a smooth solid scar, serving as ideal hemostatics in wounds of parenchymatous organs. Clute^s recently has emphasized the value of muscle transplants to the general surgeon for control of oozing in the field of operation. He states that troublesome bleeding may be readily stopped by the use of either free or viable muscle grafts.

METHOD

In our experiments perforations made by incisions into the femoral and carotid arteries of normal dogs were closed by means of muscle flaps applied to or around the vessels. This procedure is not difficult and is well adapted for immediate hemostasis, permanent healing, and the preservation of normal patency of the vessel lumen. Tissue juices exude from the raw muscle and precipitate fibrin within a few minutes *along the plane of contact between the living muscle and the wall of the injured artery*. The fibrin adheres firmly, retracts promptly, and acts mechanically to close all minute openings through which blood might escape. In five to ten minutes the adhesion formed is sufficiently firm to resist arterial pressure. Ordinarily there is little tendency to stasis or occluding thrombosis, and the function of the vessel as a blood carrier is rapidly restored to normal.

The following principles of technique are important in successful experimental repair of a wounded artery by the application of a muscle flap. Immediate hemostasis is accomplished by finger pressure on the muscle flap over the wounded area. The freshly denuded muscle, having a good pedicle, is applied either directly to the vessel wall, or is wrapped in a suitable number of coils around the artery. Good apposition is obtained by firm pressure for one minute with the overlying fingers. Continued pressure may be necessary for several minutes, usually from five to ten, while all crevices through which blood might escape are being sealed by precipitation and retraction of fibrin. The finger pressure applied at this time should not be sufficient to produce appreciable stasis within the vessel. The flow of blood under full force is allowed as soon as possible, under control of pressure carefully applied to the artery on the cardiac side of the flap. If desired, retaining sutures may be placed through the folds of the muscle flap. The preparation is tested by obliterating the pulse toward the heart to see if the pulse disappears simultaneously peripheral to the flap. There is usually no doubt about the transmission of blood with full pulsation through the area of repair. Preliminary suture of the vessel followed immediately by application of a muscle flap may be advisable. This would reduce the foreign surface exposed to the blood stream and lessen any tendency to thrombosis and traumatic aneurysm. However, sutures frequently induce thrombosis because of serious constriction of the vessel lumen, and they sometimes fail to hold in the presence of infection of the vessel wall.

The method described originated following a series of experiments done in 1930, in which we⁹ studied experimental thrombosis in dogs by the application of silver nitrate solution to the surface of veins; also by injection of small amounts of tissue extract, containing tissue fibrinogen, into the lumen of isolated vein segments. Our results were interpreted in accordance with the views of Wooldridge⁶ and Mills¹⁰ on the functions of tissue fibrinogen in the coagulation of blood; that is, the silver nitrate thrombosis was explained by the local production of tissue fibrinogen arising from injury and inflammation of the vascular endothelium.

The study of intravascular coagulation was then extended to a field of surgery in which thrombosis constitutes a serious problem. From 1931 to 1934 we assisted Dixon¹¹⁻¹³ in numerous experiments which demonstrated the efficiency of viable muscle for hemostasis. He wanted to devise a method of closing the wound after opening the sigmoid sinus in thrombophlebitis without leaving an infected foreign body, such as a gauze plug, within or upon the vein. Experiments were done to determine the utility of viable muscle flaps inserted intravenously or applied extravenously in dogs; also, analogous experiments in which muscle flaps were introduced into the line of incisions made into the liver and spleen, for the purpose of hemostasis. In 1933 we assisted Ockerblad¹⁴ in similar experiments involving the kidney and renal vein.

RESULTS

Protocols of Experiments, Series I, Normal Complete Repair.—

EXPERIMENT 1.—Dec. 18, 1936.

Operation: A linear incision, 4 mm. long, was made in the left femoral artery and covered by a flap of living muscle held by finger pressure for eight minutes. The flap was applied directly to the cut as one would press with the finger to control hemorrhage. When the finger pressure over the muscle flap was released, no bleeding occurred and there was a strong pulse throughout the artery. The muscle adhered to the artery because of precipitation of a film of fibrin. No sutures were used. The skin incision was closed.

Results: On the first, third, and fourth days after operation, a normal pulse could be felt in the femoral artery distal to the muscle flap. One year later, on Dec. 14, 1937, the artery was exposed. It was normal in size with a strong pulse. A small amount of partially atrophied and fibrosed muscle remained attached at the point of the original incision into the artery (Fig. 1*A*). It was difficult to determine where the artery had been cut by inspection of the intima (Fig. 1*B*). Healing was complete and there was no constriction or dilatation of the lumen.

EXPERIMENT 2.—

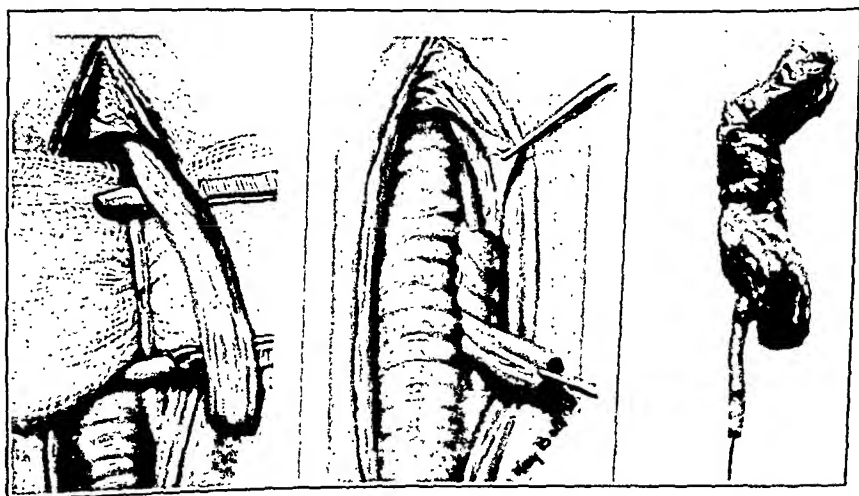
Operation: With aseptic technique, a transverse incision was made halfway through the circumference of the right carotid artery, making an opening which measured 2 mm. in width and 4.5 mm. in length (Fig. 2*A*). A muscle flap was then wrapped in two coils about the artery, and light tension was applied by means of a clamp to the free end of the cut muscle (Fig. 2*B*). Thumb and finger pressure was used for six minutes to hold the muscle in close apposition to the cut. Bleeding was



A.

B.

Fig. 1.—A, Lateral view of muscle grown to femoral artery. One-year specimen (Segment of vessel opened longitudinally; mounted between glass rods). B, Internal surface of same artery. No trace of 4 mm. longitudinal perforation.



A.

B.

C.

Fig. 2.—A, Transverse incision one-half circumference of right carotid artery. Muscle flap freed distally. B, two-coil wrap of muscle over perforation. No sutures. C, One-week specimen of flap grown to normally patent and functioning artery. No hemorrhage.

completely controlled. Two minutes later, in testing the artery for pulsation, free bleeding occurred and pressure was reapplied for a second interval of eighteen minutes. No hemorrhage followed and a good pulse could be felt going through the preparation. The skin incision was closed.

Results: On the fifth day after operation, there was drainage from the wound with edema of the soft tissues of the neck. One week after operation the vessel was exposed and a good pulse could be counted above, through, and below the muscle flap. Although the muscle was completely surrounded by about 25 c.c. of purulent exudate, it was firmly attached to the artery. The specimen containing the injured



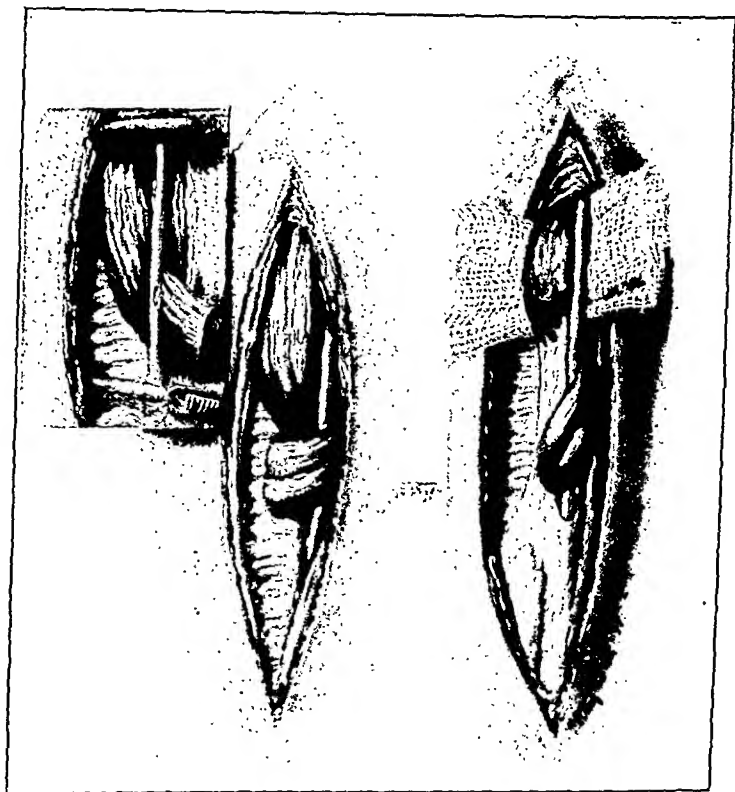
Fig. 3.—Twelve-power drawing of longitudinal section through specimen shown in Fig. 2C. Endothelium regenerated and hyperplastic in one week.



Fig. 4.—Low-power longitudinal section of specimen shown in Fig. 3. Proliferating endothelium over organizing fibrin, on a base of partially hyalinized muscle flap.

artery surrounded by muscle was removed (Fig. 2C). The muscle flap had a normal color and appearance. Healing to the vessel wall was complete despite the presence of wound infection.

Fig. 3 represents a twelve-power magnification of a longitudinal section through the isolated specimen shown in Fig. 2C. The intimal surface of the artery may be seen on either side. In the center is a darker depression which constitutes the healing wound in the vessel, with a floor of viable muscle. The entire surface shown is covered by a thin layer of endothelium, and healing is well advanced without serious deformity.



A.

B.

Fig. 5.—A. Transverse incision one-half circumference of right carotid artery, covered by one wrap of muscle flap. No sutures. B. Healed, normally functioning artery ten weeks later. No hemorrhage. Little muscular atrophy.

Fig. 4 shows a low-power longitudinal section through the shallow crater of the healing specimen shown in Fig. 3. The lumen of the vessel is above and the edge of the incision into the artery is seen at the left. The defect in the center is undergoing repair by organization of fibrin, with infiltration by mononuclear leucocytes and red cells, and is covered by proliferating endothelium. The muscle flap is seen below, partially hyalinized and degenerated, with some congestion and mononuclear infiltration. There is no evidence of hemorrhage, dilatation, or thrombosis of the vessel.

EXPERIMENT 3.—

Operation: A transverse incision was made halfway through the circumference of the right carotid artery, making an opening in which the edges separated from $\frac{1}{4}$

to $\frac{3}{16}$ of an inch at the widest point. A muscle flap was wrapped in one coil about the vessel at the point of the incision and held by finger pressure for seven and one-half minutes. (Fig. 5A.) The bleeding was entirely controlled. The vessel and the overlying muscle, attached by fibrin without sutures, were immediately adjusted in the wound and the skin incision was closed. The operation required thirty-five minutes.

Results: Two days after operation, pulsation was normal in the artery at the level of the thyroid cartilage. Because of wound infection, the incision was opened and considerable pus was found about the muscle flap. The muscle was in good condition, except for a film of exudate, and was firmly adherent to the artery. Rubber drains were inserted into the soft tissues and the skin incision was closed.



Fig. 6.—Low-power longitudinal section of healed, four-month specimen from Experiment 4. Microscopic aneurysm surrounded by hyalinized and fibrosed, degenerated muscle flap.

Observations on the third and fourth postoperative days revealed normal pulsation in the artery at the thyroid cartilage. Ten weeks after the original operation, the artery was exposed (Fig. 5B). It was easily dissected out and removed with the attached muscle. Healing was complete and the artery was normal in size and color with a strong pulsation. The attached muscle had undergone little atrophy and fibrosis.

The result was satisfactory in spite of early wound infection. Section of this artery longitudinally showed slight dilatation at the point of repair. The dilatation, however, did not seem to constitute a weakness in the vessel wall. It was lined by normal endothelium and surrounded by dense muscle. There was no outward evidence of bulging or pulsation such as one would see in gross aneurysm.

EXPERIMENT 4.—

Operation: The procedure and immediate results were identical with those described in Experiment 3.

Late Results: Four months after the original operation, the artery was exposed and found to be of normal size with a good pulse. The attached muscle presented

the normal red color and had undergone only slight atrophic fibrosis. While sponging blood in the wound, we repeatedly touched a nerve and each time produced a twitch in the attached muscle. The specimen of muscle with the enclosed artery was removed, and a membranous area about 2 mm. in diameter was found in the arterial wall at the point of the original incision. Although the tissue at this point of closure of the vessel was quite thin, it withstood pressure from a syringe attached to the artery without bulging.

Fig. 6 shows a low-power longitudinal section of the healed artery and surrounding muscle from Experiment 4. A cleftlike defect about $1\frac{1}{2}$ mm. deep is seen forming a small aneurysm in the vessel wall. The vessel wall is intact, with smooth muscle and elastic tissue, down to the base of the triangular pocket. This is formed by hyalin fibrous connective tissue, covered by a layer of endothelial cells lining the cavity. Outside and below the pocket, degenerated striated muscle is seen imbedded in hyalin fibrous connective tissue.

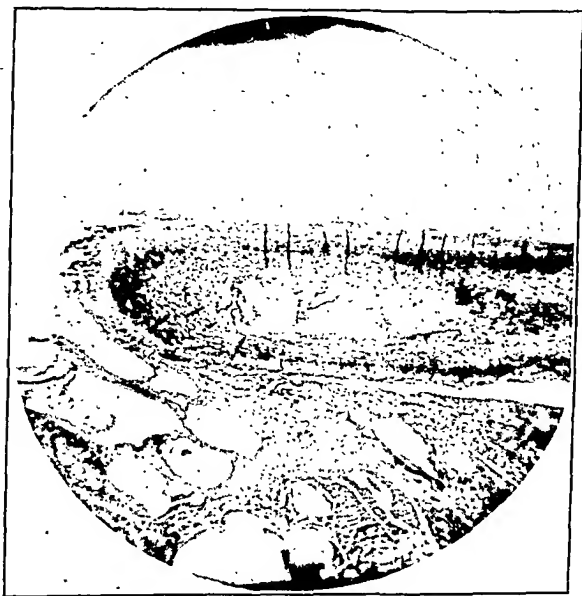


Fig. 7.—Low-power longitudinal section of occluded artery above, with attached necrotic muscle fragment below. Muscle flap repair of perforation five days previously, followed twenty-four hours later by complete section of pedicle flap. Fatal hemorrhage.

Series II, Detached Muscle, Thrombosis and Hemorrhage.—

EXPERIMENT 5.—Jan. 11, 1938.

Operation: A rectangular opening, 1 mm. wide and 6 mm. long, was made in the left carotid artery in an attempt to produce traumatic aneurysm and to study the action of devitalized muscle tissue for the control of arterial hemorrhage and repair of arterial wounds. A living muscle flap was wrapped in two coils about the opening and held by finger pressure for five minutes, after which no hemorrhage occurred and pulsations were transmitted through the muscle flap. The skin incision was closed.

Twenty-four hours later the wound was opened. A good pulse was found in the artery distal to the muscle flap. No hemorrhage had occurred. At this time the pedicle of the muscle flap was completely severed, leaving only devitalized muscle covering the wound in the artery. The incision was closed.

Results: Twenty-four hours after the pedicle of the muscle flap was severed, a good pulse could be felt in the artery in the neck. Two days afterward, the animal bled freely and the skin incision was opened. A very good pulse could be felt in the artery, and the pulsations could be seen through the overlying devitalized muscle. In fact, it seemed that there was a beginning dilatation of the artery at this point. For the purpose of reinforcement, a living muscle flap was prepared and wrapped about the devitalized muscle, covering the original incision in the artery. No bleeding occurred during this procedure.

Two days later the dog was found dead in the cage after severe hemorrhage. The neck incision was opened and clotted blood was excavated from around the muscle flap. The specimen was removed. It consisted of the left carotid artery full of clotted blood, surrounded by spongy, necrotic, and fibrosed muscle tissue attached to the arterial wall.

Fig. 7 shows a low-power section of the occluded vessel above with the attached muscle below. The lumen is filled with red cells, mononuclear and polynuclear leucocytes. Fibrin and platelets cannot be definitely identified. There is an acute inflammatory reaction in the wall of the artery, with no evidence of a healing process in the surrounding tissue. Some areas of perivascular hemorrhage are present in the necrotic muscle.

The devitalized, detached muscle was unable to resist the arterial pressure and prevent hemorrhage, although twenty-four hours of healing to the artery were allowed before the pedicle of the muscle flap was severed.

DISCUSSION

In any type of surgical repair of wounded blood vessels, perhaps the most important consideration is the possibility of development of an occluding thrombosis. Guthrie has demonstrated in the case of simple suture that thin deposits of fibrin promptly cover the raw surfaces along the suture line. This process is soon followed by resorptive changes and the formation of an intimal-like membrane which is comparable to the endothelium of a normal blood vessel. In our experiments a similar self-limiting local coagulation of fibrin probably forms on the surface of the raw muscle flaps facing the wounds in the arteries, but conditions are ordinarily not favorable to the development of thrombogenic agglutination of platelets, leucocytes, and fibrin.

In order to interpret the phenomena of fibrin formation in relation to surgery of the blood vessels, it is necessary to consider certain phases of the physiology of blood coagulation. Tissue juices and blood platelets were first shown by Wooldridge,⁶ in 1889, to contain a protein-phospholipin substance which readily clotted blood *in vivo* or *in vitro*. He named this substance tissue fibrinogen. It was his idea that blood contained one fibrinogen in solution and that the body tissues contained a second fibrinogen as a part of the cell protoplasm. Whenever blood escaped from the vessels in a wound, these two fibrinogens came together and immediate union resulted in the formation of fibrin.

In 1927, Mills¹⁰ reported on the distribution, chemistry, and manner of action of tissue fibrinogen. His results confirmed and extended the opinions first advanced by Wooldridge and are summarized as follows:

"Every cell in the body apparently contains tissue fibrinogen in its cytoplasm. The vascular endothelium is very rich in it; and thus it is

seen to be present in greatest amounts in those places where it is most needed to stop bleeding. Its functions are to shorten the latent period and to initiate coagulation; also to favor prompt retraction of the resulting clot. Tissue fibrinogen is effective in minute amounts and is powerful in its action.

"Rapid formation of tissue fibrinogen fibrin is soon followed by the liberation of thrombin and the precipitation of thrombin fibrin. The latter usually constitutes the bulk of the coagulum produced."

Recent work by Mellanby¹⁵ suggests additional functions of tissue fibrinogen in blood coagulation. He refers to tissue fibrinogen as thrombokinase and states that it not only converts prothrombin to thrombin, but also neutralizes the action of heparin. According to

CLOTTING IN WOUNDS

WOOLDRIDGE 1889
MILLS 1927

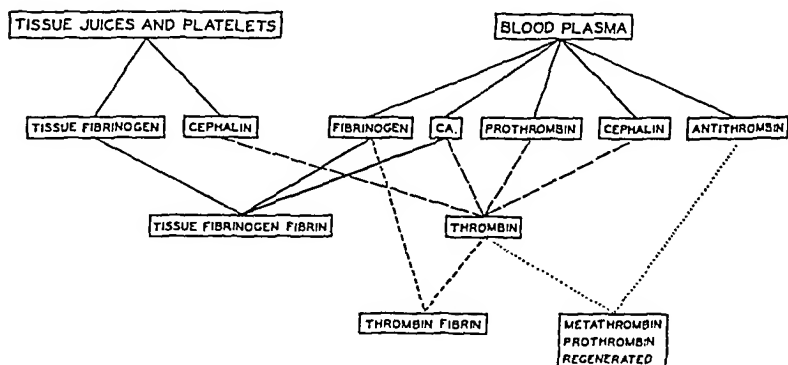


Fig. 8.—Precipitation of fibrin initiated by tissue fibrinogen (thrombokinase).

Mellanby, heparin does not prevent the conversion of prothrombin to thrombin, but inactivates the latter enzyme after it has been formed. Heparin is not present in appreciable amounts in circulating blood and is not responsible for fluidity of the blood in the living body. The blood does not clot intravascularly simply because no thrombokinase is available to convert prothrombin to the active ferment thrombin. Mellanby also suggests that heparin in the tissues serves as a local anticoagulant preventing the clotting of blood in the small vessels. The following equations represent the main factors involved in extravascular coagulation:



In our experiments with intact muscle flaps fibrin deposition was limited on the muscle surface in the plane of contact with the moving blood stream. Consequently, thrombosis occurred only when stasis was

produced by excessive compression of the arterial lumen. It is also possible that small amounts of heparin were available and that this helped to restrain and localize the coagulating action of thrombokinase liberated from the muscle.

Such a neutralizing action of heparin against the coagulant effect of thrombokinase (tissue extract, tissue fibrinogen) was demonstrated experimentally by Mason¹⁶ in 1924. During the last ten years, Murray and Best¹⁷ have showed that purified heparin is nontoxic and that it may be useful in lesions where intravascular clotting is a problem. Their results suggest that regional or general heparinization might usefully supplement muscle flap or suture repair of blood vessels by minimizing the danger of thrombosis. It may also be ventured, in turn, that the tendency to hemorrhage with the Murray and Best procedure of heparinization, where this is indicated after surgery, could be reduced by muscle flap reinforcement of suture lines in blood vessels, viscera, and other structures.

SUMMARY

The complete results of five experiments are reported from a total of eleven done on the femoral and carotid arteries of dogs.

Linear and transverse incisions in the arteries were closed and repaired, without the use of sutures, by the application of living muscle flaps to the vessel or around the vessel in one or two coils. Healing occurred without hemorrhage, thrombosis, or the formation of gross aneurysm in five animals (Series I) observed for periods of one week, ten weeks, four months, nine months, and one year. These results were checked by microscopic section of the healed specimens.

Three similar experiments (Series II) in which completely detached muscle was applied to the incised arteries promptly resulted in hemorrhage or thrombotic occlusion.

In three other experiments (Series III) hemorrhage or thrombosis occurred because of avoidable technical errors in the operative procedure.

Living muscle tissue is well adapted mechanically as a plastic tampon for immediate hemostasis. The wound in the artery is then completely sealed by rapid precipitation of fibrin between the vessel wall and the overlying muscle. This fibrin adheres firmly and retracts into a dense film which is adequate to resist the arterial pressure and prevent hemorrhage.

Fibrin is precipitated between the muscle and artery because of the presence of thrombokinase (tissue fibrinogen) in the tissue juices exuding from the raw muscle. Presumably a thin layer of fibrin is also formed on the muscle surface exposed to the blood stream, but with proper precautions there is little, if any, tendency to the inception and growth of an occluding thrombus. Probably within a few hours endo-

thelium grows over the fibrin-coated bridge of muscle covering the wound, followed by gradual atrophic fibrosis of the partially transplanted muscle tissue. It may also be assumed that the nerve and blood supply in the pedicle of the muscle flap aid in resisting the development and spread of infection and promote the growth and repair necessary for permanent healing.

We have demonstrated analogous healing and supporting effects of living muscle flaps in the repair of an incision into the common bile duct; also, to fortify the line of anastomosis against secondary infection and separation after resection of a portion of the colon. We have attempted to produce traumatic aneurysm, at present unsuccessfully, with the idea of applying living muscle in coils about the artery to support the wall and restore the lumen to normal caliber. Other applications of muscle flaps for surgical repair of visceral lesions and injuries have been suggested to us for experimental investigation.

CONCLUSIONS

1. Living muscle flaps control hemorrhage mechanically, without the aid of sutures, by closing perforations made into the larger arteries of dogs and by adhering to the vessel wall until permanent healing can take place.

2. Because of the liberation of thrombokinase (tissue fibrinogen) from the raw muscle, fibrin is chemically precipitated on all opposing surfaces. This promptly and completely seals the perforation against hemorrhage; tends to prevent the development and spread of infection; and quickly establishes a union which progresses to complete repair and restoration of normal function.

3. Muscle flap hemostasis and repair of vessels and other organs may be useful when suturing and ligation are either impractical or inadequate. Such conditions occur because of inaccessibility of the wound, and as a result of contamination, infection, unusual strain, or inherent weakness in the tissues involved.

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INITIS PLASTICA OF THE COLON

A CASE REPORT

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IN 1854 William Brinton¹ described under the term "linitis plastica" a remarkable fibrosing disease of the stomach. The stomach was described as being diffusely thickened and contracted and the cut surface recalled the appearance of woven linen, which suggested to Brinton the term "linitis." According to Bland-Sutton,² the thickening of the stomach wall ends abruptly at the pyloric ring, where the thin wall of the duodenum is in striking contrast to the thick wall of the stomach. The thickening also may involve the terminal portion of the esophagus. He further states that the "leather bottle stomach" is due to a cancerous focus in the mucous membrane—probably a chronic gastric ulcer that has become malignant—and allows the epithelial elements to permeate the connective tissue planes of the stomach. Similar changes occur in the gall bladder and colon, and this point is illustrated by a diagram of the duodenum and colon, in which the wall of the colon is greatly thickened. This latter feature is rare.

Muir² says: "Occasionally it may be difficult to recognize the condition as malignant but I have not yet seen a case of diffuse thickening of the stomach wall in which carcinoma was not found in some places. In this form the growth may occasionally spread to the wall of the bowel and mesentery leading to general thickening and fibrosis without the presence of recognizable nodules."

We have been unable to find any mention of diffuse fibrosis of the colon secondary to this fibrosing disease of the stomach in the recent literature.

There is much confusion in regard to the true nature of this condition. Boyd³ says: "The most extreme anaplasia is met with in the diffuse form but in spite of the anaplasia, the tumor is not of a high grade malignancy. . . . It may be necessary to cut a number of blocks of tissue before definite evidence of malignancy can be found. In the past, specimens of leather bottle stomach have been thought to be due to syphilis, chronic inflammation and other non-malignant conditions."

Stout⁴ says: "Even this (microscopic section) may not be infallible for both Thomson and Graham (1913) and Thalheimer and Wilensky (1917) have reported cases in which repeated sections of a stomach ulcer failed to show any primary cancer which was, however, found in the lymph nodes."

Ewing,⁵ after discussing diffuse scirrhus carcinoma, classifies a sixth stomach group as "sclerosing pyloric and diffuse fibro-carcinoma." Of this type he says: "Often there is such tremendous fibrous tissue proliferation that carcinoma cells cannot be found. Hence there is a large accumulation in the literature of groups of cases considered benign, as 'benign cirrhosis,' 'benign hypertrophic pyloric stenosis,' 'linitis plastica.' . . ." Ewing states that the great majority of these cases are probably examples of atypical cicatrizing fibrocarcinoma.

It is evident that opinion is becoming more and more in favor of regarding these cases of fibrosis of the stomach as a low grade malignant process.

The present case was followed for such a long period of time, was seen under so many circumstances, was operated upon months before death, and presented such unusual findings at autopsy, that, since it seems to illustrate all the points in the controversy on this interesting condition, it is deemed worthy of record. Recently Wolfer, of Chicago, Ill., and Ochsner, of New Orleans, La., examined the specimens removed at autopsy and both were impressed by the strangeness of the condition, and, in view of its rarity, urged that the case be reported.

CASE REPORT

The patient was first seen in 1931, seven years before death. At that time he was a thin, poorly nourished Caucasian male, 39 years of age, who gave a history of "stomach trouble" for an indefinite period of time. Roentgen studies of the stomach revealed a slight, irregular deformity of the lesser curvature, but no ulcer crater. He was told to attempt correction by diet (a modification of the Phillip King Brown diet) and that if this brought no relief, surgery might be indicated.

Instead of returning, however, when his pain became worse, he resorted to the use of soda, taking as much as a teaspoonful every two hours. The pain finally became so severe that he was forced to seek relief, and he entered The Queen's Hospital in 1936.

Examination revealed a thin, emaciated adult with local tenderness in the epigastrium, but no palpable mass. Heart, blood pressure, kidneys, etc., were in satisfactory condition. X-ray examination showed a large stomach deformity, involving the lesser curvature. Because of his miserable condition, a gastric analysis was not done. Surgery was advised and consented to.

On Nov. 24, 1936, a gastric resection was done by Moynihan II type of operation, bringing the jejunum anterior to the colon and anastomosing it to the full cut end of the stomach. A jejunostomy was also performed, the tube being placed in the jejunum and brought through the great omentum and exteriorly through a stab wound below the costal margin. The stomach was very much thickened and a large ulcer was present on the lesser curvature. At the time of operation, cancer was suspected, but a complete gastrectomy was not attempted on account of the patient's emaciated condition. The resection was made high, leaving a small pouch of the cardia, and the remaining stomach was apparently healthy, except for the thickening. The colon appeared normal and there were no palpable lymph nodes or evidence of metastatic involvement of other organs.

The patient made an uneventful recovery, except for a violent diarrhea which lasted from the eighth to the twelfth postoperative day. He was fed by the

jejunostomy tube for four days with water and Ivy's pubulum, when fluids by mouth were started. The tube was removed on the eighth day. No leakage of intestinal contents followed. The wound healed by primary union. At the time of discharge, on the eighteenth postoperative day, he was gaining two pounds a day, was relieved of all his symptoms, and stated that he was "hungry for the first time in four years."

Pathologic Examination.—A large portion of stomach was present which, upon opening, presented a large, flat ulcer on the lesser curvature, 6 cm. in diameter and 2 cm. in thickness. The edges were slightly elevated and the rugae missing on the mucosal surface. The surrounding stomach wall was thickened but showed no definite lesion. Three small lymph nodes were found which grossly were normal in appearance.

The sections taken through this lesion were made up almost entirely of masses of fibrous tissue cells. However, careful search, after cutting several blocks of tissue, revealed the presence of an occasional large, dark-staining cell, greatly compressed by the bundles of fibrous tissue. These were so few in number and so atypical that a diagnosis of malignancy was made very guardedly. Dr. W. G. Gil-mour, of New Zealand, after reviewing a few of the sections, reported fibrosis and no malignancy. Dr. Max Cutler, of Chicago, stated that there was no malignancy in the sections examined but that cancer should be strongly suspected. Said Dr. James Ewing: "The stomach section shows very suggestive signs of cancer, atrophic type, which results from late diffuse, fibrosing gastric cancer. I find quite a few rather large, opaque, granular cells in soft connective tissues and between the muscle bundles. In some cells there are numerous globules. The character of infiltration of the muscle also resembles cancer. However, I cannot find any groups of perfectly clear cancer cells and therefore I am not absolutely certain of the diagnosis." Microscopic examination of the perigastric lymph nodes showed no evidence of metastatic involvement.

Further Course.—Following operation, the patient gained thirty pounds in weight and was relieved of all symptoms for ten months. Then his appetite began to fail, he began to lose weight, and he started on a gradual downhill course with occasional attacks of vomiting. In January, 1938, he spent several weeks in a hospital in California but became progressively worse and returned to re-enter The Queen's Hospital on March 21, 1938.

At that time his condition was as follows: There was marked emaciation. There was salivation, occasional vomiting, hiccups, abdominal pain, visible peristalsis of the colon, great difficulty in moving the bowels, loss of strength, and anemia. X-ray studies of the stomach showed free emptying with most of the barium scattered through the small intestine in one and one-half hours. The barium enema passed as far as the splenic flexure but could not be forced beyond this point, and barium from the meal given the day before remained in the proximal colon. There was apparently a stenosis of the splenic flexure, separating the barium given by meal from that given by enema. The proctoscope was passed with difficulty and showed a contracted bowel with no ulceration. He was prepared for operation over a period of eight days by three blood transfusions and on other days received glucose solution intravenously.

On March 29, 1938, a laparotomy was done which revealed the small pouch of stomach in satisfactory condition as to function. The transverse colon was very much distended, prolapsed, and bound down by the omentum which was adherent to the abdominal wall. A finger could be passed under the mesentery of the jejunum as it crossed the transverse colon, but from here on the left colon showed a remarkable condition. From the splenic flexure to the rectum, the large intestine was like a straight, hard, thickened tube, about one-third normal size. Roughly, the right colon was the size of a clenched fist and the left colon the size of a thumb. No

nodules could be found and the liver showed no evidence of metastatic involvement. A colostomy was done and a biopsy was taken from the contracted left colon. This showed only fibrous tissue with no evidence of carcinoma.

The patient was considerably relieved by the operation. His pain, vomiting, salivation, and hiccups all ceased, but in spite of taking adequate nourishment, he continued to grow weaker and more emaciated and became very depressed mentally. Two weeks after returning home, he committed suicide by hanging.

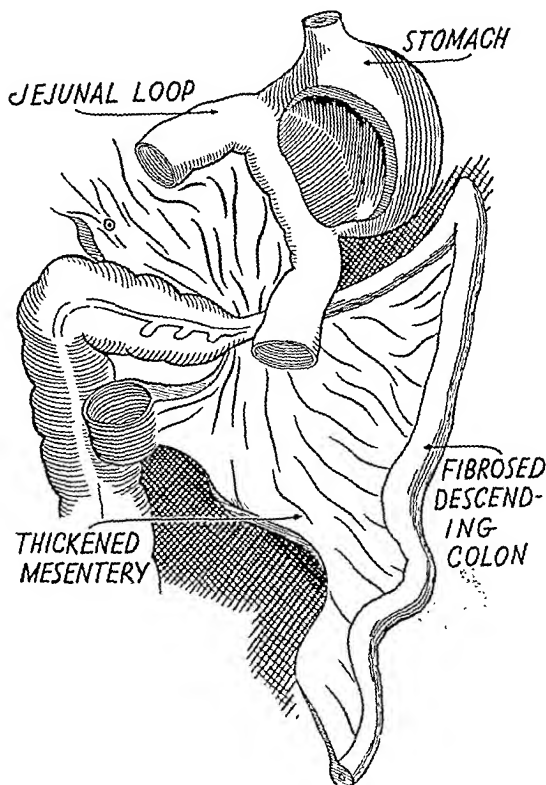


Fig. 1.—Diagram showing the fibrosed descending colon.

Autopsy Report.—The body was that of an emaciated white male of middle age. The heart and lungs showed no abnormality. No free fluid was found in the peritoneal cavity. The liver was average in size and, upon sectioning, showed no evidence of neoplastic involvement. A small stomach pouch remained which had been anastomosed to a loop of jejunum. The wall of the stomach was diffusely and uniformly thickened, measuring between 1 and 2 cm. in thickness. This thickening involved the terminal portion of the esophagus, but no obstruction was present. The gastroenterostomy stoma was patent. The colon, from the middle of the transverse to the rectum, was diffusely and uniformly contracted with a very narrow lumen and a thick, firm fibrous wall which measured over 0.5 cm. in thickness (Fig. 1). The greatest diameter was not over 2 cm. and the lumen was very small, 1 or 2 mm. to 0.5 cm. in diameter. The cecum, ascending colon, and hepatic flexure were thin-walled and normal in appearance. The small bowel, with the exception of the duodenum, showed no pathologic change. The mesentery of the small bowel was greatly thickened and the duodenum and pancreas were bound up in a mass of

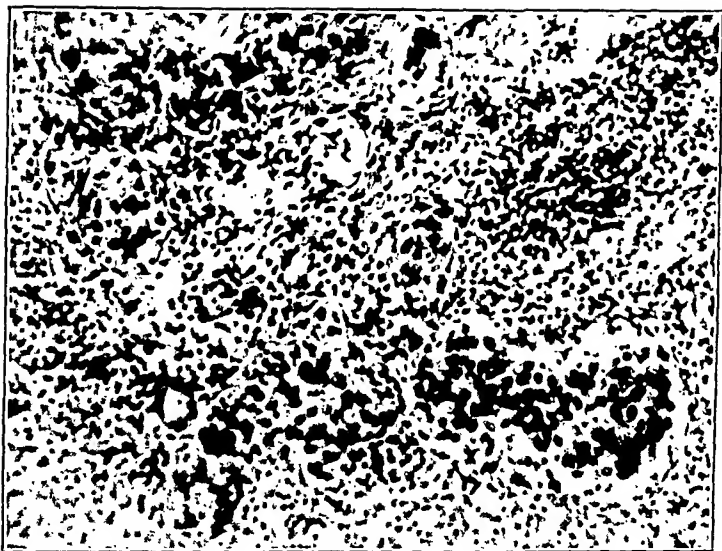


Fig. 2.—Photomicrograph, medium power, showing groups of carcinoma cells in a peripancreatic lymph node.

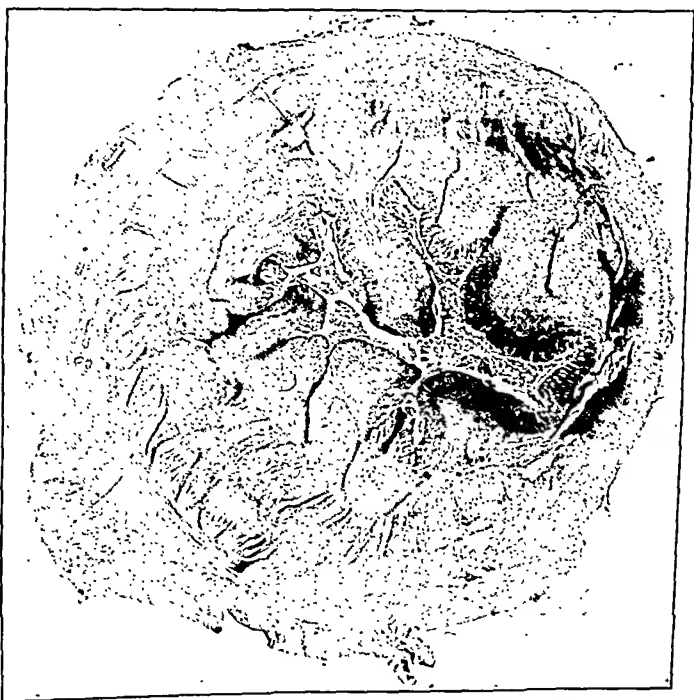


Fig. 3.—Photomicrograph, low power, showing the greatly thickened wall of the descending colon and the narrowed lumen.

thickened fibrous tissue. The pancreas, upon sectioning, showed no involvement, although several lymph nodes 1 cm. in diameter, were found on the surface. The adrenals and kidneys were normal in appearance.

Microscopic examination left no doubt as to the presence of a malignant process, although the fibrosis picture was still dominant. Nests of large mucus-containing cells were found in the peripancreatic lymph nodes (Fig. 2), although these showed no gross evidence of metastasis. Sections taken from the terminal portion of the esophagus, the stomach, and the thickened mesentery, all showed dense fibrous tissue, with an occasional group of compressed, dark-staining cells, obviously of epithelial origin. Fig. 3 depicts the tremendous thickening of the wall of the descending colon and the greatly narrowed lumen. In some blocks no trace of carcinoma could be found; in others, nests of unmistakable carcinoma cells were present, most numerous on the serosal surface or just beneath, but also found in the submucosa and fibrosed muscle layer (Fig. 4).



Fig. 4.—Photomicrograph, high power, showing a nest of carcinoma cells in the wall of the descending colon.

DISCUSSION

If we could conceive of a flow of molasses beginning at the gastrojejunal attachment and issuing over the whole left posterior peritoneal wall, carelessly spilling around the common duct, the mesentery, and the surface of the posterior wall, it would give us a better idea of the picture seen at autopsy. The abrupt transition at the middle of the transverse colon, between normal and contracted bowel, suggests that the flow involved the bowel at this point, causing the obstruction, and then turned to the left, involving the whole of the descending colon and sigmoid, even to and involving the rectal wall. This fibrosing process extended over the whole area, as if the molasses had spread where it could. Wherever sections were taken, from the remnant of stomach,

from the mesentery, from the posterior peritoneal wall, from the transverse and descending colon, from the sigmoid, the process was the same—an extreme process of fibrous tissue formation with occasional groups and clumps of large, dark, malignant cells. Because of this, we feel that the term “malignant fibrosis” would be a better designation for this process than the various terms used at present.

The history in this case strongly suggests that the disease began as a benign ulcer. Certainly the symptoms were definite enough to produce a striking picture of stomach disease over a period of seven years. In most cases the early symptoms are few and frequently the lesion cannot be demonstrated by x-ray. The clinical picture is that of a very chronic disease of the stomach. The fibrosing process possibly may be regarded as nature’s way of defending the body from the inroad of malignant cells. We are inclined to feel, since the fibrosing process is so slow, is so without definite demarcation, and the symptoms come so late, that at present no form of therapy offers much hope for recovery.

It is amazing that such a thin-walled, pliable structure as the colon could have been converted into such a small, thick-walled, rigid tube. Certainly the malignant cells must have grown very slowly and must have possessed tremendous potentialities for connective tissue stimulation. Their appearance suggests that they must often have been choked off and killed by the excessive fibrous tissue growth which they produced.

This condition should be clearly differentiated from other forms of gastric malignancy in which the duration of life is very seldom more than two years from the beginning of symptoms. We strongly suggest the term “malignant fibrosis,” since not infrequently the pathologist, from sections removed at surgery, is unable to find sufficient cellular evidence to make a clear-cut diagnosis of gastric malignancy. To popularize the term “malignant fibrosis” may save the clinician and surgeon from too optimistic an outlook when the microscope reveals only a mass of fibrous cells. From the study of this case, Ewing’s contention seems justifiable; i.e., that cases of “leather bottle stomach,” “gastric fibrosis,” “linitis plastica,” and “gastric cirrhosis” are probably always malignant. The confusion arises from the extreme chronicity and the difficulty of finding definitely malignant areas. All of these points, we believe, are well illustrated by the present case. This patient continued working for years. Excellent pathologists pronounced the first lesion removed “nonmalignant.” The roentgenologist failed to find definite x-ray evidence of malignancy. Following surgery, in spite of the extensive process within, the patient’s condition picked up dramatically. Without an autopsy, the case well could have been considered “nonmalignant.” We believe much of the present confusion has occurred because cases have been reported before complete and final evidence was obtained.

SUMMARY

1. A case of linitis plastica, with diffuse involvement of the descending colon, is presented with report of autopsy.

2. The term "malignant fibrosis" is suggested for this condition as being a more appropriate designation than the ones now in use and as being less apt to lead the surgeon to a false sense of optimism when the microscope reveals only fibrous tissue.

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Editorial

Minor Surgery Is Taboo

IN THE second issue of SURGERY (February, 1937) the writer published an editorial entitled "What Is Minor Surgery?" The gist of the editorial was that there could be no valid reason for the existence of the term minor surgery; that it was unfair to restrict the word minor to surgical practice when it was not applied to other branches of medicine; that no clear distinction could be made between major and minor surgery; that the latter term was useless and misleading and should be discarded. It was suggested that the following is the only possible definition: *Minor surgery is that part of surgical practice which is done by the minor surgeon.* And further, the more "minor" the surgeon, the more "major" the operation will become before he is through with it.

Reprints of this editorial were sent to the leading teachers of surgery in the United States, accompanied by the following letter:

"It seems to me that we who teach surgery to medical students should unite in an effort to eliminate the term 'minor surgery' from our nomenclature. It is a useless, dangerous term, liable at some time in the intern's career, or even while he is engaged in private practice, to endanger the life of a patient by thinking that any condition requiring surgical treatment can be regarded as 'minor.' You know, and so do I, that such a designation is unsound. It belittles the art of surgery and gives the student an erroneous conception of its practice. We should not stand by and allow such terminology to be used in our writing and teaching. I should be glad to have your reaction to this proposal."

More than 100 replies were received. They were surprisingly unanimous in the affirmative, only one dissenting opinion being expressed, that of a noted urologist. Quoted excerpts from these replies with names attached formed the basis of a paper, "The Banishment of Minor Surgery," which was published in *The Journal of the Association of the American Medical Colleges* in July, 1938. Several teachers had already removed the name "minor surgery" from their departments; others declared their intention to eliminate it from their curricula in the future and all, with the one exception noted, agreed that such a distinction should be excluded forever from our medical schools.

This much, by way of explanation and apology for another appeal to the teachers of surgery in this country to join in the effort to get rid of a term, which, to say the least, is unnecessary and which tends, not to the advancement of instruction in surgery, but to the confusion of

it. Moreover, through the precepts and examples of our surgical leaders, there may trickle down to the great mass of surgeons in America the thought that surgery should be of the same high type wherever it is needed; that none of it is minor and that all of it is surgery. Even the general practitioner who does surgery should realize his limitations, but he must understand that when he operates he is performing surgery, not minor surgery.

Let it be understood that no objection is offered to the inclusion of, and emphasis upon, such courses in surgery as are now taught to second- and third-year students. These subjects are but preliminary to later instruction in surgery as a whole, and they should deal with the essential knowledge upon which all surgery depends. Titles for such courses might well be "Principles of Surgery," "Introduction to Surgery," or "The Elements of Surgery," etc., all implying thorough groundwork in the fundamentals upon which all surgery rests. To refer to these courses as "minor surgery" is to under-rate their importance and to debase their purpose. Our objection, then, is not directed to matter or method of instruction, but to the use of a term to misrepresent a vital part in our teaching and our practice.

The crusade is on. Let those who abhor the sin of inaccuracy, who believe that words are mighty things for help or hindrance, who know that it is just as easy to be right as to be wrong, and far more becoming, unite in an attempt to keep out of our already muddled medical terminology this fruitless expression "minor surgery." On the contrary, let those who are content in their enjoyment of "standpatism," who think that mere terms make no difference, who yet believe distinctions between the grades of surgery can be made, let those classify themselves accordingly and say whether they are minor surgeons, major surgeons, perhaps supreme surgeons, or just surgeons. After all, the difference between a minor and a major operation may depend entirely upon the one who performs it.

—Hubert A. Royster, M.D.
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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

THE ESSENTIAL NATURE OF NONSPECIFIC GRANULOMATOUS LESIONS OF THE GASTROINTESTINAL TRACT

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IN THIS communication attention is being concentrated upon a group of intestinal inflammatory lesions to which Moscheowitz and I¹⁶² had called attention in 1923 and in 1927 and which we had, in want of a better name, designated as nonspecific granulomas of the intestine. Since the publication of these reports, a pronounced and continuing interest in this disease has followed so that a review of the knowledge accumulated in the last fifteen years by myself and many other observers seems to be in order.

The group of heterogenous intestinal benign lesions—colitis, inflammatory lesions, diverticulitis, nonspecific granulomas, etc.—show a certain amount of overlapping in their biologic and pathologic manifestations. In the last group of nonspecific granulomas, considerable confusion has been unnecessarily created by various attempts which have unwisely and prematurely been made to segregate various subgroups as somewhat independent clinical entities mostly upon an anatomic situational basis instead of upon the firm foundation of pathologic change.

It seems best, at the very outset, to define the class of cases which we (Wilensky and Moscheowitz¹⁶²) had originally differentiated out from the group of seemingly related lesions and had designated as nonspecific* granulomas and to which this review and discussion are limited. Since our first communication, the lesion has been discussed under a wide variety of terminologies and for purposes of clarity these are recapitulated here in order to avoid any confusion which might arise because of the multiplicity of names which various observers have employed.

The terms "inflammatory tumor," "nonspecific inflammatory tumor," "infective granuloma" (Mock¹⁰⁹), "benign granuloma," "terminal ileitis," "sclerosing ileitis," "chronic interstitial enteritis" (Dalziel¹²), "nonspecific granuloma" (Wilensky and Moscheowitz¹⁶²), "chronic cicatrizing enteritis" (Harris, Bell, and Brunn⁷⁴), "regional ileitis" (Crohn, Ginzburg, and Oppenheimer,³⁷ Brown, Borgen, and Weber²⁴), "hypertrophic ulcerative stenosis of the terminal ileum," "localized hypertrophic colitis" (Ginzburg and Oppenheimer⁶³), "ileo-

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*The term nonspecific should be considered to convey the idea that the lesion is a nonspecific one only because its etiologic cause is still obscure and has not yet been definitely established and accepted by all.

colitis ulcerosa chronica" (Rosenblate, Goldsmith, and Strauss¹³⁷), "entzündlich-fibrose Darmstriktur" (Rotter,¹³⁸ Kocher⁹⁰), "pseudo-cancer" (Le Dentu⁹⁷), "chronic ulcerative enteritis" (Corr and Boeck³⁵), "inflammatory fibrous large intestine strictures" (Rotter,¹³⁸ Koch⁸⁹), all have reference to the same underlying and essential pathologic condition. This list does not include the various terminologies used when the condition is confounded with similar lesions arising in association with colitis, diverticulitis, etc.

By all accounts, at the present writing, the term most in favor seems to be nonspecific granuloma; this is possibly the best for the present because the term does not assume too much, indicates the nonspecificity of the lesion, and determines the lesion as an inflammatory, and not as a neoplastic phenomenon.

Characteristics of Nonspecific Granulomatous Lesions of the Alimentary Canal.—The characteristics of nonspecific granuloma of the alimentary tract are best described by a recapitulation of its pathology and clinical manifestations.

Pathology.—The abundant observations reported in the literature since our (Wilensky and Moschcowitz^{113, 162}) original reports in 1923 and 1927 have added no perceptible increase to our knowledge of the anatomic picture of these granulomatous lesions. The lesion most commonly involves various part of the intestinal tract, and the site most frequently involved is the neighborhood of the ileocolic junction. The bowel wall is infiltrated, thickened, "rubbery," and rigid; and the normal contour is lost. The infiltration may be more prominent on the free or on the mesenteric side, or it may surround the bowel entirely; and, in any instance, the lumen is narrowed. Abundant adhesions may or may not be present. Several coils of intestine may be connected by perforations; or the perforation may be part of a fistulous tract communicating with the skin, or the bladder. Walled-off abscesses may be present, either in the intraperitoneal space or in the retroperitoneal tissues. In one case of my own there was a diffuse seropurulent intraperitoneal exudate.

In comparatively fresh cases, the lymph channels seem to be engaged in the general inflammatory reaction. The appropriate lymph glands are often swollen and enlarged and are the seat of an acute adenitis. That a lymphangitis of some kind is present seems to be doubtless.

Grossly and microscopically, the specimens show various degrees of acute, subacute, and chronic inflammatory change throughout the wall of the intestine, particularly in the mucosa, where there is also marked destruction of an irregular type. In some instances the entire mucosa is gone; at other times only the surface epithelium is destroyed. Rarely, in very old cases, there is a tendency to polypoid formations. In the terminal ileum cases the Peyer's patches are not prominent or visible.

Microscopically, the granuloma reveals a mass of chronic granulation tissue in which the chief elements are mononuclear cells and lymphoid cells. Other areas are densely infiltrated with polymorphonuclear leucocytes. The picture may vary from fibroblastic and lymphoid tissue surrounding areas of necrosis to well-defined connective tissue stroma with developing blood vessels. Abundant areas of vascular organizing fibrous tissue and older more mature scar tissue testify to the ineffectual reparative effort which seems constantly to go hand in hand with the destructive process; this tissue forms the major part of the thickening and accounts for the secondary stenosis of the bowel wall and lumen.

Lymphadenoid tissue is much less in amount and in a case of any duration it seems to have disappeared entirely. Solitary and aggregated lymphadenoid follicles are broken up, or in process of destruction or have disappeared entirely. In the terminal ileum the same effects are noted in Peyer's patches.

The presence of giant cells is a common finding. All observers agree they are due to the presence of particles of nonabsorbable vegetable matter which have become incorporated within the lesion as a result of deep ulceration and are encapsulated within the healing scar tissues. They were found by Antopol in the serous and subserous layers of the bowel, as well as within the submucosa, and the indication seems to be that they traverse the bowel wall through the lymphatic channels. The picture resembles an irritative process which contributes in producing the marked hyperplastic fibrosis seen in the sections. The confusion of these nonspecific lesions with tuberculosis is mostly due to the presence of these giant cells plus the appearance on the serosa of small elevations, discretely placed, simulating tubercles; and this is probably responsible for the classification of a great many of the cases in previous reports as instances of tuberculosis.

A multicentric origin of these lesions has been described.

In the case reported by Dudley and Miscall,⁴⁶ a 37-year-old female was operated upon three times for gastric symptoms of the retention type with prompt recurrences of symptoms. "Pathologic examination of the tissue removed from the jejunum at the first operation showed a stenosing lemon-sized tumor of the jejunum. It was interpreted as a chronic, productive inflammatory tissue. The mucosa was slightly ulcerated and the tumor showed a marked amount of fibrosis with infiltration with lymphoid cells. Some giant cells were also present."

The post-mortem examination showed the presence of two other similar tumors, one in the duodenum and one low down in the jejunum.

Symptomatology.—The symptomatology of nonspecific granuloma is intimately associated with its morphologic characteristics:

1. The stage of acute, subacute, or chronic enteritis or colitis, with recrudescences of the latter frequently including bloody diarrhea, etc.

If the lesion is situated in the right iliac fossa, the symptoms commonly reproduce those of an acute, subacute, or chronic appendicitis; if in the left iliac fossa, those of an acute diverticulitis with or without perforation.

2. In many postoperative cases (e.g., appendicectomy) the picture is more or less dominated by the presence of an intestinal fistula. Nowadays the nature of the lesion is commonly correctly suspected and proved at secondary operations.

3. In a very large proportion of the cases the clinical picture is chiefly one associated with an incomplete or almost complete intestinal obstruction; many of these are suspected strongly of being caused by a neoplasm; and many of these suspicions are apparently but incorrectly substantiated by roentgenologic findings.

4. In a few, the essential symptom is the presence of an intra-abdominal mass. These, also, are commonly suspected of being neoplastic in nature and, again, the picture is commonly similarly substantiated by roentgenologic evidence.

Commonly there is a mixture of symptoms and objective findings either at the same time or at various times. In a few, the clinical findings at one time or another include all of the above.

These are the groups of clinical phenomena upon which all symptomatology is built. Very often complicating factors add their own peculiar manifestations to the preceding; these include massive hemorrhages leading to various degrees of microcytic anemia, free or walled-off perforations, strictures (intestinal obstruction), fistulas, and inflammatory masses (exudate, suppuration, adhesions, etc.). Not so well known general manifestations are usually due to associated forms of colitis and include general bacterial infections (including endocarditis), arthritis, neuritis, ulcerations of the skin and mucous membranes, dermatoses, eye lesions and, in very sick patients, parotitis. The Mayos have described a number of cases of malignant degeneration of these granulomatous lesions.

In old cases the factors of anemia, loss of weight and strength, and general debilitation add their quota to the clinical picture.

Corroboratory roentgenologic evidence is always sought for, is practically always found, and is sometimes misleading. When the intestinal lesions are those of an enteritis or colitis and occupy relatively long segments of bowel, the roentgenographic visualizations show long segments of narrowing, shortening, rigidity, and lack of the usual markings in the pattern of mucosal relief. When the intestinal lesion is relatively short and the clinical picture is that of an obstruction, the mimicry to the usually found visualizations of a neoplastic lesion is marked and causes errors in diagnosis.

Other laboratory (bacteriologic, immunologic, etc.) evidence is not positive enough at the present writing to be of sufficient diagnostic importance.

Enumeration of all of the individual signs and symptoms of non-specific granuloma of the alimentary tract would entail a more or less exhaustive description of all intra-abdominal diagnosis. The multiplicity and diversity of the individual symptoms preclude any high degree of accuracy so that the consequent high percentage of error makes it important and essential for the operator in any individual instance to be able to diagnose correctly the lesion and to differentiate it from simulating carcinomas and other lesions.

ANALYSIS OF AVAILABLE KNOWLEDGE OF GRANULOMATOUS LESIONS

Historical.—The earliest references to this lesion were made in the period when pathology was not as securely supported upon the associated sciences and they must therefore be accepted with reservations. The case described by John Abercrombie¹ in 1828 should be so considered. The principal lesion with which nonspecific granuloma was confounded was tuberculosis. Undoubtedly many lesions unassociated with the intestinal wall but interpreted as being of intestinal origin were included because of contiguity of structure. It is only in the last fifteen years that more accurate segregation of the case has been possible.

The earliest reference seems to be that of Virchow¹⁵⁸ in 1853. He described single or multiple indurative, apparently inflammatory, masses in the region of the appendix and the various divisions of the large gut which in some of the cases were associated with stenotic manifestations. It is not clear why these lesions were associated in Virchow's¹⁵⁸ mind with forms of chronic peritonitis. Korte and Salzer⁹³ each made short references to similar cases.

Around the turn of the century, references were made to this ill-defined group of inflammatory "tumors" by Arnsperger³ and others and it began to be understood that the lesion might be due to, or might accompany, a number of other etiologic factors. The experiences of Rotter¹³⁸ and Koch⁸⁹ were especially important in contributing to this uncertainty and the latter invented the term "inflammatory fibrous large intestine strictures" to indicate the group. Nevertheless, in 1909 Gangitano⁶⁵ relapsed into the previous confusion between these and true neoplastic tumors of the large gut.

In 1906 Moynihan¹¹⁵ described six cases in which he demonstrated inflammatory tumors in the large intestine during operation in patients in whom before exploration he had confidently expected to find malignancies. He differentiated these tumors from tuberculosis, thought that these inflammatory tumors were possibly more frequent than anyone had supposed up to that time, and gave an accurate description of the pathology and of the possible local complications. It was not possible for Moynihan¹¹⁵ to offer any etiologic explanation.

In 1908 Mayo-Robson¹⁰⁴ clearly separated eleven cases of "tumors" of the alimentary canal, occurring in the esophagus, stomach, small intestine, cecum, and the various divisions of the large gut extending down to the rectum, from cases of specific inflammation and from malignancy. His experience tallies with that of the present day: the surprise at finding an inflammatory tumor instead of a neoplasm; the frequent unexpected and astonishing results which followed side-tracking operations in apparently inoperable neoplastic disease; and, because of this, he advised exploration even in seemingly impossible cases.

In 1909, Braun²² added three cases of his own to the previous experience; in these cases the lesions were situated in the splenic flexure. One of these was operated upon and a recurrence followed an unsuccessful or incomplete operation; in the other two there was a spontaneous disappearance of the "inflammatory tumors." His description of the disease confirmed those previously made in Germany, England, and France. I feel quite sure, however, that more than one inflammatory intestinal lesion is confounded in these reports, not the least of which are various forms of intestinal diverticulitis.

Up to 1917 case reports continued to appear sporadically: Giffin's⁶⁶ and McGrath's¹⁰⁵ cases should be excluded because they were cases of diverticulitis. Lee's⁹⁸ case demonstrated the possibility of perforation and abscess formation.

In 1920 Tietze¹⁵⁴ reviewed all of the preceding experiences and described additional cases of his own. His own experience indicated to him that in uncomplicated form these inflammatory tumors involved mainly the large intestine, and that they led to the formation of extraordinary adhesions between the gut and the neighboring organs and tissues. However, he recognized fully that these lesions involved other parts of the alimentary canal; but he saw the lesions in the great majority of the cases in the neighborhood of the peritoneum and even thought that the infiltration might originate in the latter structure. He referred to other similar lesions in other situations to which we shall refer subsequently. In listing his experiences he divided the cases into groups dealing with (1) traumatism and foreign bodies; (2) inflammatory tumors proceeding from the appendix and cecum; (3) inflammatory large intestinal thickening associated with colitis and pericolitis; (4) acute and chronic forms of sigmoiditis; (5) dysentery and colitis ulcerosa; (6) diverticulitis; (7) lesions originating in the female pelvic organs; and (8) a group of obscure, not etiologically defined cases. In discussing the etiology of these inflammatory conditions. Tietze¹⁵⁴ implicates intestinal wall phlegmon, trauma, vascular disturbances, and foreign bodies; and he discusses primary typhlitis, the various forms of colitis, pericolitis and dysentery, and diverticulitis.

In 1923, Moscheowitz and Wilensky¹⁶² reported 4 cases in which the lesion was situated in the large intestine. In 1927, Wilensky and

Moschcowitz¹⁶² reported additional cases with the lesion in the small intestine. These two papers brought the attention of the profession, in this country especially, to this peculiar lesion and since then all sorts of cases occurring in all parts of the alimentary canal have been reported in the literature. These include the reports of Barron,¹⁵ Mock,¹⁰⁹ Erdmann and Burt,⁵⁰ Crohn, Ginzburg, and Oppenheimer,³⁷ Harris, Bell, and Brunn,⁷⁴ Homans and Haas,⁷⁵ Jones and Eisenberg,⁸⁴ Golob,⁷⁰ Coffen,³⁰ Dudley and Miscall,⁴⁶ Koster, Kasman and Sheinfeld,⁹⁴ etc. Most of these papers are purely clinical.

In elucidating the pathogenesis and biologic characteristics of this disease, Crohn, Ginzburg, and Oppenheimer³⁷ separated out the clinical group which occur in the terminal part of the small intestine and attempted to segregate them as a distinct disease under the term regional ileitis. Since their report, however, many observers, including some others in the Mt. Sinai group, have commented upon the inaccuracy of this hypothesis, have reported numerous cases occurring in other parts of the alimentary canal, and have grouped all of them under and in one category. Fortunately, this misconception appears now to have been checked.

Mock's¹⁰⁹ report included the hypothesis that the condition was initiated by trauma and was associated with a diminished vascular supply; subsequently a necrotizing process progresses equally with a reparative process until the tumorlike mass is formed. While, undoubtedly, these phenomena are apparent in the pathologic picture, it seems more accurate to say that they are parts of a larger process of which they are by no means the cause.

Erdmann and Burt⁵⁰ believed that unidentified toxins in the intestinal tract might initiate the lesion when in contact with a traumatized mucosa. Razzoboni suggested a virus infection. Both of these suggestions need verification.

The reports of Dudley and Miscall⁴⁶ and of Koster, Kasman, and Sheinfeld⁹⁴ indicate strongly the wide distribution of nonspecific granulomas throughout the alimentary tract. Examples are quoted from the literature in which the lesion has occurred even in the esophagus and the rectum as well as in all other anatomic divisions.

The cases reported by Koster, Kasman, and Sheinfeld⁹⁴ should be taken with some reservations. Twelve of his seventeen cases had histories which extended from two to six days; another case had symptoms for two weeks. The pathologic pictures described include "slightly injected appendix," "slight injection and thickening of the ileum," "enlarged mesenteric glands," and "oedematous mesentery." All of these cases need considerable follow-up and other observations before they can be finally accepted as cases of nonspecific granuloma.

Frequency.—The number of case reports which have accumulated in the literature year by year seems to show a progressive increase only

because observers are alive to the subject and because it appears that the disease is not a rare one. Many cases reported in the literature under a variety of other nomenclatures probably add to the total number of cases and to the frequency with which the disease affects individuals. According to Clark, between 500 and 600 cases already have been reported in the literature and the number of unreported cases surely must be very much larger.

Racial and Vocational Distribution.—Cases occur under all sorts of circumstances in all classes of people; in rich and in poor people; in the leisured class and in those who are actively engaged in various occupations; in various parts of the world; in white people and in the colored; in members of various religious denominations or sects. Apparently the disease is widespread in every sense.

*Epidemiology.**—The lesion is always an isolated occurrence. It never occurs in epidemic form and it never is communicated to anyone in the same ward, family, or ethnologic, vocational or other group. Felsen⁵¹ has reported an incidence of approximately 10 per cent after a localized outbreak of dysentery, in which subsequently evidence occurred demonstrable by sigmoidoscopic, roentgenologic, operative, or post-mortem methods of intestinal lesions. That these cases were true cases of nonspecific granuloma was not always established beyond all doubt except in three cases; the inference, however, was given (see discussion on dysentery, page 303). There is, however, no corroboratory evidence elsewhere.

Age.—Nonspecific granuloma of the alimentary tract occurs at all ages and periods of life. The youngest case reported (Koster⁹⁴) was seven years old; the oldest cases were in the sixth decade of life (quoted by Koster and co-workers⁹⁴). In 96 cases reported in the literature (Homans and Haas,⁷⁸ Koster and co-workers,⁹⁴ Mixer,¹⁰⁸ etc.), the age incidence is as follows:

Under 10 years	7 cases
11 to 20 years	15 years
21 to 30 years	28 cases
31 to 40 years	22 cases
41 to 50 years	13 cases
51 to 60 years	6 cases
61 to 70 years	5 cases

*New York City statistics for 1935 and 1936 subdivide the cases of intestinal disease as follows:

	1935			1936		
	Males	Females	Total	Males	Females	Total
Amoebic dysentery	3	3	6	1	-	1
Bacillary	10	9	19	11	6	17
Unspecified	3	-	3	-	-	-
Other diseases	48	43	91	68	65	133
Total	40,768	34,289	75,057	42,289	35,349	77,638

Granulomatous lesions are not listed separately.

A majority of the cases occur in the age-period in which acute appendicitis and mesenteric adenitis are prevalent. This will be referred to again subsequently in this communication.

Sex.—The sex incidence varies with different observers. Mixer,¹⁰⁸ of Boston, and the Mt. Sinai group (New York) report an incidence twice as great in male patients as in female patients. On the other hand, in the 62 cases collected from the literature by Koster⁹⁴ and others, there were 33 males and 29 female subjects. I do not believe that any kind of importance can be assigned to either group of statistics because there are too many outside environmental, racial, and other influences which might make differences, as is demonstrated in the two tabulations quoted. There has been no marked difference in the cases which have come under my own observation.

Bacteriology.—Almost all of the workers in this problem have attempted to find evidences of the essential bacteriologic cause, but up to the present time none has been acceptable to all observers. The usual pyogenic organisms are definitely excluded. The usual bacteriologic content of the bowel is found in so many normal and abnormal circumstances that it can also definitely be excluded. Because of certain similarities to the lymphogranulomatous type of lesion, studies (Frei tests) have been undertaken along this line by Koster⁹⁴ and others, but the tests all yielded negative results.

There are references in the literature (Christopher,²⁶ etc.) to the association of this lesion with amoebic colitis. This association is a rare one, so that it seems definite that amoebae alone are not responsible for the lesion under discussion.

There is a good deal of difference of opinion as regards the role of infection by the dysentery group of organisms. Felsen⁵¹ (see below) is the chief, if not the only, proponent of this theory, supporting his viewpoint by bacteriologic and agglutination data. A personal communication from Borgen,¹² of the Mayo Clinic, concludes by saying that he "would deduce that organisms of the dysentery group have no relation to this condition."

Pumphrey's studies (Mayo Clinic)¹²⁶ also have yielded negative results: Many organisms both singly and in mixed groups were recovered by him, gram-positive and gram-negative rods, gram-positive diplococci, and gram-positive streptococci in chains; but even when some of the organisms seemed to assume some importance because of their predominance in more or less pure culture, no organisms of the dysentery group were found and no other conclusive evidence. Curiously enough, when Pumphrey could obtain specimens without fecal contamination, there was commonly no growth of bacteria. In Moek's¹⁰⁹ experience the granulomas are sterile. Pumphrey's¹²⁶ studies also showed no relation to any nasopharyngeal infection.

In none of the cases is there any evidence of any relationship to tuberculous infection either in culture, in gross and microscopic appearances, or in the presence of other definite tuberculous lesions elsewhere in the body.

Occasionally, a syphilitic infection is present (Stafford's¹⁴⁴ case). The rarity of this association plus the gross and microscopic anatomic characteristics are enough to establish the fact that any coincidence of this kind is accidental and does not indicate the essential cause of non-specific granuloma.

All of these facts are in complete accord with my own experiences in the cases which have come under my care.

Distribution in the Alimentary Canal.—The following (Table I) is the anatomic distribution of nonspecific granuloma of the alimentary canal as reported in the literature and from my own experience:

TABLE I

	NO. OF CASES
Esophagus	1
Pylorus	4
Stomach	4
Stomach, duodenum, and pancreas	1
Small intestine	3
Jejunum	9
Ileum	52
Cecum	4
Appendix	3
Colon	2
Ascending colon	1
Transverse colon	3
Splenic flexure	2
Transverse colon and splenic flexure	1
Sigmoid	7
Rectum	4
Cecum and ileum	21
Cecum and ascending colon	3
Cecum, ileum, and colon	3
Colon and ileum	1
Splenic flexure and small intestine	1
Rectum, cecum, and small intestine	1
Total	131

THE RELATIONSHIP OF NONSPECIFIC GRANULOMA OF THE GASTROINTESTINAL TRACT TO PRECEDING ACUTE AND/OR CHRONIC INFLAMMATORY LESIONS IN THE SAME SITUATION

1. *The Relationship of Nonspecific Granuloma in the Terminal Ileum or Cecum to Any Preceding Attacks of Appendicitis and/or Appendicectomies.*—About 58 per cent of the cases collected from the literature (Table I) occurred at or on either or both sides of the ileocecal junction. The possible role of the appendix seems an important one.

In about 50 per cent of the cases of nonspecific granuloma in this anatomic situation, a history of a previous appendicectomy is obtained.

In a small percentage of these it is stated that the appendix was not inflamed or otherwise changed and that the appendiceectomy was done as a "prophylactic" or other incident during the course of an exploration during which the essential lesion in the adjacent portion of the alimentary canal was sometimes recognized, sometimes not understood, and sometimes not demonstrably present.

Acute inflammatory processes in the intestinal wall with hyperemic and edematous swelling of its wall and succulent enlargement of the appropriate lymph nodes of various degrees are described by Koster and co-workers,⁶⁴ Ravdin and Rhodes,¹³⁰ Mixter,¹⁰⁸ Binney,¹⁸ Probstein and Gruenfeld,¹²⁴ and Dudley and Miscall,⁴⁶ etc. In many of these cases the duration of the illness has been very short and has varied from a few days to one or two weeks, and when the process was situated in the right iliac fossa (i.e., ileum, cecum) the clinical picture has resembled strongly that of an acute appendicitis.

A. An Acute Lesion Is Present Without Involvement of the Appendix:
A characteristic case is reported by Koster:⁶⁴

A 16-year-old female had been sick for three days. The operative findings included "enlarged mesenteric glands; inflammatory mass of ileum, cecum and omentum with appendix normal but adherent to congested thickened ileum; perforation of ileum near ileocecal junction walled off by omentum, with almost complete obstruction." A resection was done. The pathologic report was "chronic non-specific inflammation of ileum with stenosis of ileocecal valve." Uneventful recovery. The follow-up observations made two years later showed an absence of any subjective or objective findings. (Case 9, pp. 790-791.⁶⁴)

As far as one can tell from this report, this case might be anything but the beginnings of a granulomatous lesion; and, as pointed out previously in this communication, all cases of this kind need considerably more study and follow-up observations before they can be properly classified. However, it is quite obvious that, no matter what lesion is present nearby, the absence of any pathology in the appendix immediately excludes the latter from any culpability in the etiology of the former.

B. An Acute Lesion Is Present With Involvement of the Appendix:
In the other cases recognizable pathology is present in the appendix. In about one-half of the latter it seems quite likely from my own experience in various pathologic laboratories (and with due apologies to all concerned) that the changes noted in the appendix were involution or developmental changes which should not be classified as in any way connected with true inflammatory or other morbid processes. In the remaining cases of this group, distinct inflammatory lesions are termed "congestion," "adhesions," "oedematous," etc. It is quite apparent from all reports that these changes in the appendix are changes secondary to the presence of an inflammatory lesion near by and not in any true sense essential appendicitis.

The cases of Binney,¹⁸ Homans and Haas,⁷⁸ Harris, Bell, and Brunn,⁷⁴ etc., and most of the cases of Koster and others⁹⁴ were of this type. The case of Myer,¹¹⁴ Sale, and Ehrenfest, reported by Probst and Gruenfeld,¹²⁴ is a very good example:

There was operative demonstration of a thickened, edematous, but not acutely inflamed appendix; the last six inches of the ileum were red, swollen, and stiffened; the mesentery was not thickened and did not contain swollen glands. Only the appendix was removed. Microscopically, the mucosa of the appendix was intact; the lymphoid tissue was prominent; the subserosa was edematous. *Bacteria proteus valerii* was grown in pure culture. The patient, at the time of report, was symptomless.

C. Cases of Acute Appendicitis Followed Subsequently by the Development of a Granulomatous Lesion: Finally cases are described in which the lesions, apparently limited to the appendix and varying from mild anatomic changes to the most extensive lesions associated with acutely inflamed, gangrenous and/or perforated appendices, with or without localized abscess formations and with or without peritoneal exudates or evidences of peritoneal inflammation, were followed subsequently by granulomatous lesions in the bowel nearby.

It seems very possible that in some of the cases in this group an intestinal granuloma might have been present and not demonstrated because of premature satisfaction with the apparent lesion and consequent insufficient exploration.

A most interesting experience is the following: The very first case which brought our (Wilensky and Moscheowitz¹⁶²) attention to this lesion was of this variety.

A young man developed an apparently ordinary form of appendiceal abscess. The appendix was removed and the abscess was drained. The patient then went on to make the ordinary form of apparently complete recovery. Shortly thereafter, an operatively proved granulomatous lesion developed in the cecum. It seems hard to believe that this was a mere coincidence.

I cite this case because it brings to one's mind the possibilities that are present, in respect to the subject under discussion, with other similar severe cases of apparent acute appendicitis. On the one hand, the condition may have nothing to do with granulomatous lesions and no subsequent manifestations may occur which would make us think otherwise. On the other hand, recrudescences of symptoms and lesions may occur as exemplified by this case. This phase of the subject has distinct importance in the discussion of apparently primary granulomatous lesions of the appendix itself.

1). Primary Granulomatous Lesions of the Appendix: Forms of appendicitis commonly occur, which, not being recognized or operated upon at an early stage, proceed to a stage in which excessive amounts of inflammatory granulomatous and scar tissue infiltrate and surround the appendix and commonly spread to and involve the walls of the cecum or

ascending colon or the neighboring coils of ileum so that a sizable mass is present.

A young man, in otherwise good and healthy condition and with a history of no preceding illness, developed all the clinical manifestations of an acute appendicitis. At operation a large abscess was found, and the operator, very rightly, simply drained the abscess. However, after many months, a sinus still remained and at the secondary operation a very thick appendix was dug out of a surrounding inflammatory induration which involved the junction of the cecum and ileum and the intestine for a very short distance on either side. The pathologic diagnosis was non-specific granuloma of the appendix. The wound healed completely and has remained so up to the present writing. (Park East Hospital, referred by Dr. M. F. Goldberger.)

In Homans and Haas⁷⁸ report two cases of appendical lesions are described. In one the appendix was "scarred"; in the other there were "active, chronic ulcerations of the appendiceal mucosa."

In Bockus and Lee's²¹ case the appendix was buried in an inflammatory mass involving ileum and cecum; the appendix itself showed no ulceration, but its walls were thickened and fibrotic; the histologic section showed "a non-specific, infectious, granulomatous process throughout."

In Ravdin and Rhoades¹³⁰ case a fibroblastic lesion was present in the appendix which closely approximated that seen in ordinary forms of nonspecific granuloma. In this case the lesion extended to the cecum but an apparent cure, nevertheless, was obtained after appendicectomy alone.

These are only examples. Since the report of von Bergmann¹⁵⁹ in 1911 of cases of fibroblastic appendicitis, other cases have been reported by Lawen;⁹⁶ and, in 1921, Bachlehner⁷ was able to collect 41 cases from the literature. The recent report of Ravdin and Rhoades¹³⁰ contains a number of instances and discusses the relation of fibroblastic appendicitis and granulomatous lesions in the ileum. In citing these experiences, however, one should be fully cognizant of the fact that the histologic differentiation between these forms of appendicitis and the granulomatous lesion under discussion is commonly a difficult one and that, in the absence of other bacteriologic, serologic, and perhaps other verification, the differentiation is commonly a clinical one based on whether the operative wound does or does not heal readily and permanently and without any subsequent recrudescence of symptoms or fistulas.

Such an experience tends to show very definitely that a nonspecific granuloma may begin in the appendix. If the original infection contains elements which are foreign to the essential cause of these granulomas (whatever that may be) and the former are sufficiently virulent to cause gangrene, it is possible and likely that the latter elements (i.e., the essential cause of the granulomas) may be stamped out and no further manifestation need follow; or, an indurative form of inflamma-

tion follows and persists to give subsequent clinical trouble and necessitate further operative measures.

In view of all of this accumulated experience one is compelled to the opinion coinciding with that of Homans and Haas⁷⁸ that the statement of Crohn, Ginzburg, and Oppenheimer³⁷ that "the appendix is always free from guilt and free from changes" does not meet the facts and is incorrect.

2. *The Relationship of Nonspecific Granuloma to Gastric Ulcer and/or Other Gastric Inflammatory Lesions.*—One must exclude those gastric ulcers which are ulcerated carcinomas, those uncommon instances in which carcinoma becomes implanted upon an underlying benign ulceration, and cases due to tuberculosis or syphilitic infection. There remain the following groups of cases:

A. *Chronic gastric ulcers* are noted for their large size, their indurated base and margin, the excessive production of granulosomatous tissue in the gastric wall surrounding the lesion, and the presence of inflammatory enlargement of the related lymph nodes. A number of anatomic studies (Grossman, etc.) have shown the importance of the lymphangitis in the deeper layers of the stomach wall spreading outwards from the ulcer area as a characteristic accompaniment. The French school consider the persistence of this infection to be the essential cause of the non-healing of the gastric defect.

B. *Inflammatory masses occur in the gastric wall* in which ulceration is absent or of practically no importance. The cases of Robson,¹³³ Moock,¹⁰⁹ and Kolodny⁹¹ are of this nature and have been classified by them as nonspecific granulomas. In Koldony's⁹¹ case the mucosa was eroded; there was small cell infiltration followed by fibroblastic scarring; and giant cells were dispersed among the fibroblasts. The similarity of the lesion to the intestinal lesion is marked.

C. *The relationship of this type of lesion to leather-bottle stomach (schrumpfmagen)* is a problematic one. Among various hypotheses, it has been suggested (Aschoff,⁵ etc.) that linitis plastica has some relationship to foreign body inclusions or that it is a possible result of previous acute inflammatory or phlegmonous lesions.

The importance of lymphatic involvement and spread of the lesion in each of these groups seems apparent.

3. *The Relationship of Nonspecific Granuloma to Diverticulosis.*—Diverticula abound in all parts of the intestine. The commonest sites are the sigmoid, the other parts of the large intestine, and the ileum. Two varieties of inflammation exist:

A. *Acute Diverticulitis:* In one group a well-defined diverticulum becomes inflamed; commonly, a more or less complete subsidence of the process and its symptoms occurs (this is especially so in the sigmoid) and in some of these recurrences occur. In the small intestine any

degree of symptomatology invites a more or less urgent surgical intervention; the offending diverticulum is removed and a lasting cure follows:

An instructive experience is the following:

A young unmarried woman, 24 years of age, gave a history of a number of attacks of vomiting and abdominal cramps extending over a period of eight months. Then an acute attack of abdominal pain and vomiting occurred for which she was operated upon on my service by Dr. Kaufman following the diagnosis of "acute appendicitis." The operative findings included an appendix which "was normal in appearance," a Meckel's diverticulum situated 14 inches from the ileocecal junction which "showed no gross evidences of an 'ileitic lesion,'" and "unquestionable terminal ileitis," lymph nodes which showed definite pathologic changes, and an absence of anything resembling tubercles. The appendix and the diverticulum were removed and an uneventful convalescence was made.

The microscopic examination of the appendix made by Dr. Felsen showed "deep intra- and intermuscular cellular infiltration chiefly with mononuclear cells, but also some polymorphonuclears." The diverticulum showed "chronic intramural infection. Intramuscular infiltration by lymphocytes and some plasma cells; focal round cell intermuscular. No giant cells seen. Hypertrophy of myenteric plexuses."

The patient's serum did not agglutinate *Bacillus typhosus* or *B. paratyphosus* A and B at the end of twenty-four hours. The Frei test was negative. (Bronx Hospital, No. 87012.)

A recurrence of symptoms took place about six months later. The further history is, however, not available at present.

In this instance the diverticulum acted exactly like the appendix, and, whatever was said regarding the relationship of the appendix to a granulomatous lesion would apply with equal force and importance to the diverticulum.

B. Chronic Lesions: In the other group no such dramatic course of events takes place. Symptoms develop slowly and progressively and usually they are referred to the large intestine. A mass develops. The case is studied roentgenologically and a diagnosis of malignancy is commonly made. At operation the part of the intestine which harbors the mass is removed. Pathologic examination shows a considerable amount of perisigmoidal inflammation, adhesion, and thickening; a considerable degree of bowel wall thickening; and more or less stenosis of the lumen. The microscopic picture includes an intramural infiltration with inflammatory cells, an intramural fibrosis, and hyperplasia. The diverticula are commonly difficult to demonstrate. If it were not for the demonstrable diverticula, the lesion would be classified as a nonspecific granuloma. In the presence of the diverticula another element seems to be present related to the development of the granulomatous lesion.

In the cecum this corresponds in the old nomenclature to "typhlitis."

4. The Relationship of Nonspecific Granulomatous Lesions of the Large Intestine to Preceding Attacks of Colitis.—The terms colitis or ulcerative colitis are loose expressions which cover a clinical condition,

associated usually with diarrhea. By laboratory data the group is subdivided into cases of (A) amoebic colitis, (B) bacillary dysentery, and (C) ulcerative colitis of undetermined etiology.

A. Amoebic Colitis: Rarely, extraordinary amounts of inflammatory tissue infiltrate the wall of the intestine in an area which is the seat of amoebic disease and definite formations occur which are mistaken for neoplastic lesions.

In Kartulis⁸⁷ case the thickness of the bowel wall measured 22 cm. Runyon and Herrick¹³⁹ describe four cases; Harrison,⁷⁶ Cope,³⁴ Rogers,¹³⁵ and Lasnier,⁹⁵ all report instances; and in James and Deeks⁸¹ case the infiltration nearly closed the lumen of the bowel and a clinical and roentgenologic diagnosis of malignancy was made.

In the case reported by Corr and Boeck,³⁵ there was "a small mass in the cecum. The terminal six inches of the ileum were normal. The ileum, proximal to this, was large, 'wet' and hose-like; a red inflamed linear area was prominently exhibited in the serosa. There were a few white, longitudinal girdle scars throughout the involved bowel; these caused stenosis with almost complete obstruction, the uppermost scar was about three feet distal to the pylorus."

In the case reported by Gunn and Howard sections taken through the base of the ulcer showed "a fibrinopurulent exudate containing pyknotic and fragmented nuclei. An infiltration of round cells extended through the remaining portions of the partly destroyed muscularis. Prominent dense collections of lymphocytes grouped in nodules resembling true lymphoid nodules were seen, particularly in the submucosa and subserosa of all the specimens. There was a marked formation of edematous fibrous tissue with scanty infiltration of round cells, plasma cells and eosinophils outside the area of lymphoid nodular infiltration. Sections taken from the granuloma away from the ulcer showed a similar structure, the muscularis being preserved, and fibrous tissue formation taking place in the submucosa and subserosa. The mucous membrane was normal in appearance while the substantia propria contained numerous eosinophilic leukocytes. Occasional giant cells of the foreign body type were seen in the areas of fibrosis and round cell infiltration." Gunn and Howard aptly call these lesions amoebic granulomas of the bowel.

The demonstration of the amoebic nature of the infection demarcates the original etiology of the lesion. Nevertheless, in view of the usual pathologic-anatomic picture associated with amoebiasis, the demonstration of a granulomatous type of lesion indicates that another factor has entered.

B. Cases of Bacillary Dysentery: Ordinarily infections of the intestinal wall with organisms of the dysentery group go through a primary acute stage and a later chronic stage which is frequently marked with reactivation of the infection and recrudescences of the acute inflammatory process. In acute bacillary dysentery there is diffuse lymphoid

hyperplasia of the solitary and aggregated (Peyer's patches) lymphadenoid follicles, in a diffusely reddened and edematous bowel wall in which the bulk of the lesion, comparatively speaking, is placed superficially. The lymphadenoid follicles become larger later and begin to undergo necrosis. Healing occurs rapidly in uncomplicated cases. Without a clear line of demarcation, the acute stage of the disease may pass imperceptibly into a subsequent chronic stage marked by secondary intramural infection and suppuration. Intramural abscesses, when in the submucosal layer, commonly break through into the lumen of the bowel and perhaps account for much of the mucosal ulceration. When in the deeper parts of the intestinal wall, the abscesses may break through into the general peritoneal cavity or into the retroperitoneal space. In the peritoneal cases the site of the lesion usually but not always becomes well walled off and a general peritonitis does not occur. However, I, personally, have had at least one experience in which a fatal gangrenous peritonitis followed.

In the final stage an extensive reparative intramural fibrosis follows. The lymphadenoid follicles disappear and the intestinal wall becomes a thick rigid tube, consisting chiefly of vascularized connective tissue. A segmental or general distribution of the lesion may be present. Essentially at this time the pathology reveals intramural infection, fibrosis with many giant cells, and a decisively undifferentiable bacteriology.

Felsen has reported that he has observed the development of a chronic granulomatous lesion from the acute form of the disease in 14 instances. Schwartzman and Winkelstein¹⁶⁴ also have made the same observation. Felsen also has observed the subsequent development of a chronic ulcerative colitis in 25 other cases. In the Jersey City epidemic of dysentery, Felsen found, by means of roentgenographic, sigmoidoscopic, operative, and autopsy methods, that "visible evidence of chronic distal ileitis or ulcerative colitis was obtained in 13 (10.7 per cent) of a total of 122 patients 9 to 12 months after the initial attack of bacillary dysentery or roughly one out of every ten patients. It is possible that these figures would have been higher if routine roentgenographic examinations had been made in every return study." However, as Winkelstein¹⁶⁴ so well points out, "the pathologic sigmoidoscopic, stool, and radiographic features of any chronic ulcerative colitis (amoebic, bacillary, or indeterminate) may be identical although the etiology differs. This, of course, is probably due to the importance of the secondary invaders in the chronic stages of these diseases." This leaves only 3 cases out of a total of 122 patients with satisfactory positive evidence.

C. Cases of Chronic Ulcerative Colitis of Undetermined Etiology: The third group of colitis cases with undetermined etiology lately has assumed an important position. Hurst,⁷⁹ of London, in 1926 and in the last few years Felsen,⁵¹ of New York, have sponsored the opinion that ulcerative colitis of previously undetermined etiology is a late stage

of bacillary dysentery. Felsen outlines the development of the lesion to include (a) the stage of acute bacillary dysentery, (b) the stage of chronic bacillary dysentery with discrete focal lymphoid necroses and/or "geographic" denudations of the mucous membrane, and (c) a late stage of "nonspecific" ulcerative colitis in which the "specific" organism of the dysentery group has disappeared and been replaced by secondary invaders, usually of the enterococcus or colon groups, and in which the original pathologic changes have been replaced by intramural infection with or without intramural abscess formation and by dense mural fibrosis in an attempt at healing. Felsen's conception is supported by bacteriologic and serologic tests; the latter, however, have received rather insufficient corroboration in other laboratories up to the present time.

(To be continued in the September issue of the Journal)

Review of Recent Meetings

REVIEW OF THE MEETING OF THE AMERICAN SURGICAL ASSOCIATION, HOT SPRINGS, VA., MAY 11-13, 1939

WARREN H. COLE, M.D., CHICAGO, ILL.

(From the Department of Surgery, University of Illinois, College of Medicine)

William Darrach, New York, N. Y.: **Osteochondritis of Knee.**—Attention was called to the relation of trauma to osteochondritis. The term chondrosis was suggested as preferable to osteochondritis. Opposing surfaces are usually affected; e.g., anterior surface of femoral condyles and the posterior surface of the patella. Fragmentation, fissures, and myxomatous changes are important pathologic features. Loose bodies are frequent. At operation the affected cartilage is shaved off, leaving the surface as smooth as possible.

In discussion Kellogg Speed, Chicago, Ill. (read by J. D. Bisgard, Omaha, Neb.) called attention to the insidious onset and to the not infrequent confusion diagnostically with loose cartilage. The diagnosis may be missed unless the knee joint is opened with a large incision.

Robert E. Gross and Elliott C. Cutler, Boston, Mass.: **Surgical Management of the Patent Ductus Arteriosus.**—Persistence of the fetal vascular opening between the aortic arch and pulmonary artery may lead to serious cardiac disorder in late childhood or adult life because of superimposed subacute bacterial endocarditis or because of cardiac decompensation resulting from what is essentially an arteriovenous communication. Surgical exploration and obliteration of the persistent ductus was proposed as a rational procedure in the attempt to avoid the fatal complications resulting from this abnormal vascular channel. Report was made of experimental work on dogs which was undertaken to develop an adequate surgical approach and exposure of the superior mediastinum. The low diastolic pressure which is so diagnostic was corrected by ligation of the ductus. Other symptoms were likewise relieved in a very satisfactory manner.

In discussion Mont Reid, Cincinnati, Ohio, called attention to the fact that, even though many patients with a patent ductus arteriosus have few if any symptoms, there are many indeed who succumb to such diseases as bacterial endocarditis, and if early operation is performed a fatal outcome might be prevented. Dr. Cutler disclaimed credit for the work and extended credit to Dr. Gross for instigating and carrying out the work.

Frank L. Meleney, New York, N. Y.: **The Combined Use of Zinc Peroxide and Sulfanilamide in the Treatment of Chronic Undermining Burrowing Ulcers Due to the Microaerophilic Hemolytic Streptococcus.**—Inasmuch as the causative organism in chronic undermining burrowing ulcers is a microaerophilic hemolytic streptococcus, the recent advent of sulfanilamide naturally has led to its use in these cases. From the recent successful treatment of twenty of these unusual infections, it has been possible to judge the relative merits of these two forms of treatment when used separately and when combined. Observations indicate that as soon as the

diagnosis is made the lesion should be widely opened or excised so as to permit adequate contact with zinc peroxide. In some cases the rate of healing will be hastened by the supplementary administration of sulfanilamide, but it should not be used as the sole treatment of the infection, for in most cases it fails to control the disease and in some patients it may be extremely toxic.

In discussion **William Parsons**, New York, N. Y., stressed the necessity of meticulous care of the wound regarding cleanliness, etc. **H. E. Pearce**, Rochester, N. Y., reported good results with zinc peroxide, as given by the author. **Robert Harris**, Toronto, Canada, called attention to the fact that the administration of nicotinic acid reduces the symptoms of toxicity of sulfanilamide.

D. E. Robertson and (by invitation) **A. W. Farmer**, Toronto, Ont.: **Treatment of Avulsed Skin Flaps.**—Four such cases are reported with a new method of treatment. The treatment advocated by the authors consists of the complete removal of the avulsed skin flap. This is converted into a full thickness graft by removal from it of the subcutaneous fat. Following the usual cleansing and débridement of the denuded area, the graft is sutured into the defect from which it was removed. With the "take" of such a graft, the patient is saved weeks of hospitalization associated with the sloughing and eventual grafting of cases of severe avulsion of skin. Movies were shown to demonstrate healing with freedom from cicatrization.

In discussion, **Sumner Koch**, Chicago, Ill., brought up the question as to whether or not it was advisable to cut the attachment of the flaps, since many of the flaps would live anyway. He emphasized the necessity of cleaning the fat carefully from the skin flaps. **John Homans**, Boston, Mass., remarked that this principle was similar to that which he was utilizing in his operative treatment of elephantiasis, but that it might be an improvement in elephantiasis to completely excise the skin flaps and adopt the authors' principle in toto. **Arthur Shipley**, Baltimore, Md., called attention to the pliability of the tissues involved in the graft as shown in the movies.

Joe Vincent Meigs, Boston, Mass.: **Cases of Fibroma of the Ovary With Fluid in the Abdomen.**—Fibroma of the ovary with ascites is a well-known entity and most textbooks mention it. Fibroma of the ovary with ascites and pleural effusion was first reported as an entity by Meigs and Cass in 1937. Since that report, eight more cases can be added to the original seven. Thus this syndrome reaches real proportions and it is probable that some patients with such a benign tumor are among those condemned to die of ovarian cancer with supposed metastasis to the chest. There is a lack of appreciation of the importance of ovarian fibroma in producing the symptoms of malignant disease. The reason for the fluid in the chest is not known, but that it is due to the fibroma is sure, for upon removal of the tumor the chest fluid disappears. This paper analyzes the problem and describes the fifteen cases.

In discussion, **James Masson**, Rochester, Minn., reported two similar cases.

Lester R. Dragstedt and (by invitation) **Dwight E. Clark** and **C. Vermeulen**, Chicago, Ill.: **The Significance of Lipocain in Surgery.**—The pancreas normally supplies a second internal secretion, apart from insulin; it is necessary for survival after removal of the pancreas. The authors have called this hormone lipocain. When the pancreas is removed or extensively destroyed by disease, a deficiency of this hormone occurs, which results in extreme fatty infiltration and degeneration of the liver. Lipocain has been secured in active form in various types of extracts of pancreas, and by the oral or subcutaneous administration of this substance the symptoms and signs of its deficiency can be corrected. Lecithin and choline, likewise, have a beneficial effect upon correcting the fat infiltration.

Extracts were prepared free from lecithin and almost free from choline and were found to be effective, thus proving that the active principle is not lecithin and choline.

Alfred Blalock and (by invitation) Samuel S. Riven and Morton F. Mason, Nashville, Tenn.: Myasthenia Gravis. Consideration of Diagnosis and Therapy With Report of Response Following Removal of Tumor of Thymic Region.—The case of a young female patient with severe myasthenia of at least four years' duration with an associated tumor of the thymic region was presented. Her response to treatment with glycine and moderate doses of ephedrine was unsatisfactory. However, prostigmin afforded relief, although large repeated doses were frequently necessary. X-ray therapy did not alter the symptoms. Removal of the tumor three years ago has been followed by remarkable improvement. The only experience similar to the authors' was that of Schumacher and Roth in which hyperthyroidism was a complicating factor. Results appear to justify further study of the effects of thymectomy on those subjects with myasthenia gravis and associated thymic tumors.

In discussion, **Roy D. McClure, Detroit, Mich.**, reported ten cases of thymic tumor, none of which, however, had myasthenia gravis. **George J. Heuer, New York, N. Y.**, reported several cases of thymic tumor, all of which were carcinoma. **Peter Heinbecker, St. Louis, Mo.**, reported that some recent studies he had made indicated that the etiology from the standpoint of the muscle was not located in the myoneural junction but had to do with the inability of the muscle to synthesize or build up the substances necessary for function.

Peter Heinbecker, St. Louis, Mo.: The Role of the Pituitary Gland in Water Balance.—Experimental evidence was presented to indicate that maximum diabetes insipidus results only after functional or anatomical removal of all the pars nervosa; i.e., infundibular process, stalk, and median eminence. The anterior lobe of the hypophysis, while not essential for the existence of a permanent state of diabetes insipidus, normally probably plays a diuretic role which is not to be explained solely through its thyrotropic action or in the maintenance of a normal basal metabolic rate. If thyroidectomy is performed in the diabetic dog before the diabetes is permanent (i.e., within two or three weeks following operation on the hypophysis), the diabetes is completely relieved. If thyroidectomy is performed after the diabetes is permanent (i.e., several weeks after production of the diabetes), the relief from diabetes is only partial. In a case of diabetes insipidus in a human being, upon whom thyroidectomy was performed, the urine output was reduced by 25 per cent.

In discussion **Loyal Davis, Chicago, Ill.**, remarked that these results were similar to those of Ranson and associates except that they considered the anterior lobe essential for maintenance of diabetes insipidus.

F. L. Reichert and (by invitation) F. Gerbode, San Francisco, Calif., and F. J. Halford, Honolulu, H. I.: Sclerosing or Retractable Mesenteritis.—Circulatory disturbances of the mesentery produced experimentally resulted in a retractile mesenteritis when all vessels (artery, vein, and lymphatic) to a segment of bowel were tied off or when only the lymphatics to the segment were ligated. These studies were found to be an extension of the recent Italian investigations of Jurn and of Milone and Picco. Although we still find mesenteritis clinically, the modern textbooks of surgery have omitted this condition. In seeking proper treatment for the contracted and scarred mesentery, the application of the electrosurgical knife was found to be successful for mild mesenteritis and for intra-abdominal adhesions.

In discussion **John Homans**, Boston, Mass., called attention to the fact that usually lymphatics show a tendency to regenerate, but in these experiments they apparently remained blocked and became disorganized.

Albert O. Singleton, Galveston, Tex.: **Intracranial Arteriovenous Aneurysms.**—Four cases of intracranial arteriovenous fistulas were reported, two of the cirroid and two carotid cavernous communications. Various methods of treatment were discussed, including ligation of the internal carotid, common carotid, and extracranial injection of the ophthalmic veins. The latter method proved successful in a case in which it was tried, but the author cautioned that complications might be produced. The author likewise warned that carotid ligation was a serious procedure, even in children.

In discussion **Mont Reid**, Cincinnati, Ohio, added that treatment of arteriovenous aneurysms involving branches of the external carotid may fail because of collaterals. He reported a case relieved by ligation of the external carotid above the ascending pharyngeal which had recurred when seen seven years later. Ligation of the ascending pharyngeal afforded relief with slight recurrence later.

J. Dewey Bisgard and (by invitation) **E. K. Johnson**, Omaha, Neb.: **Studies of Gastrointestinal Tone and Motility; The Influence of Certain Drugs and Anesthetics.**—The influence of commonly used drugs and of the various types of anesthetic agents, including spinal, nitrous oxide, cyclopropane, ether, avertin, and barbiturates, upon gastrointestinal tone and motility was studied both in patients and animals. The activity of the stomach and bowel was measured by inserting into the stomach and small intestine a small inflated balloon attached to the end of a tube which was connected to a water manometer. Continuous tracings were made over a period of several hours. The tone of both the stomach and intestine was increased by morphine, pitressin, and by spinal and cyclopropane anesthetics. The tone was decreased by nitroglycerin, atropine, and scopolamine and by nitrous oxide, ether, and barbiturates. The least disturbance in normal gastric and intestinal activity occurred in patients and animals who received the combined anesthetic agents, avertin rectally and cyclopropane by inhalation. Following this form of anesthesia, the tone and activity of both the stomach and bowel showed least disturbance not only during anesthesia but also subsequent to anesthesia.

Edwin M. Miller, Chicago, Ill.: **Congenital Obstruction of the Duodenum.**—The infant born with an obstruction of the duodenum demands the best in surgical judgment and technique if successful results are to be obtained. The obstruction may be within the lumen, as from a partial or complete atresia, or from without as from a fibrous band, direct pressure from the root of the mesentery, or an actual twist of the jejunum on the axis of the superior mesenteric artery. The clinical picture often simulates closely that of congenital pyloric obstruction, but usually the presence of bile in the vomitus is the distinguishing feature. In all cases the x-ray evidence after giving barium will accurately define the lower limit of the obstructed portion. The treatment is always surgical, but the type of operation depends upon the type and location of pathology. The author presents eight personal cases, five of which resulted successfully. Posterior gastroenterostomy was performed in four, duodenojejunostomy in three, and Ladd's operation in one. Success in this field of surgery depends largely upon accuracy of technique and the use of the finest of suture material, to say nothing of the postoperative management.

In discussion **William E. Ladd**, Boston, Mass., called attention to the fact that in his experience obstruction due to extrinsic obstruction, such as faulty rotation, had been more common than in Miller's experience. His operation designed for the correction of volvulus associated with faulty rotation consisted of untwisting

the volvulus and exposing the duodenum throughout the whole course. **Edward Donovan**, New York, N. Y., cautioned against the diagnostic use of barium because of the danger of perforation.

J. Shelton Horsley, Richmond, Va.: **Peptic Ulcers of the Stomach and Duodenum Perforating Into the Pancreas.**—These ulcers almost constitute a clinical entity. The pain and discomfort are frequently continuous and do not readily respond to medical treatment. There is also a considerable danger of hemorrhage. A further complication of this type of ulcer is a pancreatitis which can produce rather serious involvement of the pancreas. For these reasons, medical treatment is often unsatisfactory, and a partial gastrectomy, preferably a modification of the Billroth I procedure, seems to be indicated in most cases. In doing this operation a block dissection method is used and a small amount of the adherent pancreas is shaved off with a hot electric cautery without opening the ulcer. There are occasional instances of extensive involvement of the pancreas in which a less radical operation is applicable. To obviate the necessity of a Wangensteen tube for two or three days postoperatively, the author reported that he frequently resorted to a gastrostomy.

In discussion, **John Finney**, Baltimore, Md., emphasized the necessity of resection of the stomach in the ulcers under discussion, particularly if they were bleeding. **Frank Lahey**, Boston, Mass., disagreed with the use of the Billroth I type of operation on the grounds that such a procedure would discourage the radical removal of a large amount of stomach. He favors the Finsterer principle, not resecting the ulcer if resection is apt to crowd the papilla of Vater. **Roscoe Graham**, Toronto, Ont., reported a fatal case of pancreatitis resulting from resection of a portion of the pancreas with the ulcer and emphasized preoperative decompression to relieve edema.

Ralph Colp and (by invitation) **Leon Ginzburg** and **Marcy L. Sussman**, New York, N. Y.: **Ileocolostomy With Exclusion.**—Ileocolostomy with exclusion is frequently performed, both in inflammatory diseases of the terminal ileum, cecum, and ascending colon, and as a first-stage procedure in resections for benign and malignant lesions of the right colon. This study is composed of twenty-four cases of regional ileitis, inflammatory lesions, and nonspecific granulomas limited to the right half of the colon, and neoplasms of the proximal colon in which either an ileotransverse colostomy, or ileosigmoidostomy with ileal division was performed. The author favored ileocolostomy in an end-to-side fashion rather than a side-to-side type of anastomosis, because in his experience ulcers in the blind loop of ileum, if side-to-side anastomosis is done, may develop. Rarely did he encounter ulceration in the blind loop of cecum.

In discussion **Vernon C. David**, Chicago, Ill., urged that in the transverse and descending colon, ileocolostomy should be performed as far proximally as possible so as to avoid liquid stools.

Fred W. Rankin, Lexington, Ky.: **The Value of Cecostomy as a Complementary and Decompressive Operation.**—Decompression of the colon by cecostomy is indicated in subacute and acute obstruction of the rectosigmoid and left colon. The procedure may be done "blindly" or with exploration as circumstances indicate. Cecostomy is useful as the first stage of a graded radical combined perineo-abdominal resection of the rectum when at exploration the preliminary medical decompression has been ineffectual. As a complementary step to obstructive resection of the colon or resection and anastomosis for carcinoma, cecostomy is invaluable. The technique of cecostomy differs according to the indications for its employment. A wing catheter introduced into the cecum after Witzel's method and brought out through a stab wound in the groin is most useful as a comple-

mentary maneuver. When decompression is performed for acute or subacute obstruction, exteriorization of the whole cecum over a glass tube completely bypasses the fecal current.

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Damon B. Pfeiffer, Philadelphia, Pa., and (by invitation) **Edward M. Kent**, Abington, Pa.: **The Value of Preliminary Colostomy in Surgical Correction of Gastrojejunocolic Fistula.**—Two recent cases of gastrojejunocolic fistula are reported. In both cases a new principle of treatment in this condition was employed; namely, preliminary ascending colostomy followed in a few months by radical repair of the lesion. In the first case primary radical surgery was too hazardous owing to the patient's precarious condition and a local involvement about the fistulous tract. A preliminary colostomy was done with dramatic improvement in general and local symptoms. Within three months there was a gain of fifty pounds in weight. At secondary operation complete subsidence of local inflammation rendered the repair simple. The colostomy was later closed in the usual manner. A second case was treated in a similar manner, also with successful outcome. It is felt that this method may be of great assistance in reducing the very high mortality in the surgical treatment of gastrojejunocolic fistula. It would seem that the debility of these patients may be due to continual feeding upon colonic contents. The inflammatory reaction about the fistula may be due in part to continual reinfection from the colon. The high mortality is chiefly due to a prolonged procedure upon inflamed structures in a patient with lowered resistance. With both these factors ameliorated by preliminary colostomy, the present operative mortality should be reduced.

In discussion, **Frank Lahey**, Boston, Mass., likewise stated that contamination is a serious drawback in resection of gastrojejunocolic fistula. To obviate this, he has devised a two-stage procedure.

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them, in some cases, is confused and incomplete. Consideration of the qualities an anesthetic agent should have offers a yardstick for measuring and evaluating new substances. Constant criteria whereby new agents logically may be judged not only from the standpoint of the pharmacologist but also from that of the surgeon are described. The necessity of a very large number of cases for determination of death rate due to the anesthetic agent alone was stressed.

Wesley Bourne, Westmount, Que. (by invitation): Trends in Inhalation Anesthesia.—Numerous and various attempts have been made to dispel, lessen, and alleviate the injurious effects of anesthetics. As results, there have been improvements in methods of administration, less harmful anesthetics have been found, and analeptics are being used. An illustrative account of the disturbances which anesthetics produce on metabolism as a whole was given, comparing the volatile with the gaseous substances. Important effects of anesthetics on the blood include acidosis and a decreased water balance. Shock is related to anhydremia and acidosis. Acidosis is lessened by a good glycogen reserve in the liver. The author favors pre- and postoperative glucose, but not glucose given during the operation. All inhalation anesthetics cause some urinary suppression.

Roy D. McClure and (by invitation) Frank W. Hartman, Detroit, Mich.: Anoxia—A Source of Possible Complications in Surgical Anesthesia.—In surgical work, any one or a combination of the various types of anoxia, that is, the anoxic, anemic, stagnant, and histotoxic types, may be observed. Present-day preoperative sedation plays a definite role, especially in the production of the stagnant and histotoxic types of anoxia. Reduction of both systolic and diastolic blood pressures frequently results from moderate or heavy sedation, particularly with the barbiturate group and avertin. Such cases reach the operating rooms with systolic blood pressures as low as 70. The oxygen saturation of the arterial blood in such cases is found to be 15 to 20 per cent below normal. At the same time a direct histotoxic anoxia is produced by these drugs as noted by Keilin, Jowett, Quastel, and others. The histotoxic anoxia coupled with the stagnant anoxia resulting from heavy preoperative sedation further may be augmented by anoxic anoxia when nitrous oxide or ether (Shaw, Steele, and Lamb) is used as the anesthetic. Spinal anesthesia also results in stagnant anoxia, unless precautions are taken to prevent reduction in blood pressure. When blood pressures are maintained at normal levels or above, the oxygen saturation of the arterial blood is likewise sustained. If several types of anoxia are combined in the same patient during and after the operation, serious lesions in the brain, liver, lungs, or adrenals may result.

Harold L. Foss, Danville, Pa.: The Present Status of Spinal Anesthesia.—Conclusions based on an experience with 5,000 consecutive operations, personally performed, in regions below the diaphragm and in which the anesthetic was spinal, were given. The author compared ultimate mortality, operating room mortality, and mortality occurring within the first forty-eight hours spaced in twelve-hour groups in 5,000 consecutive operations under spinal anesthesia and 5,000 consecutive operations under inhalation anesthesia. The author has not seen any serious cord or meningeal symptoms and there have been no resulting paralyses. Occasionally, in the follow-up studies pain in the back was noted as a complaint. In the last 2,000 or 3,000 cases the number of operating room deaths was about the same in the spinal anesthesia group as in the other group.

John S. Lundy, Rochester, Minn. (by invitation): Intravenous and Regional Anesthesia.—The intravenous method of inducing a state of anesthesia is the newest and probably the most interesting method of producing insensitivity to pain

at the surgeon's disposal. The technique of administration of evipal sodium and pentothal sodium is in a process of rapid development and future use of the method will depend to some extent upon refinements of the technique that are being introduced so rapidly at the present time. Regional anesthesia recently has been made much more effective by the substitution of metycaine for procaine. There are several reasons why this substitution should have occurred and did occur. A combination of regional anesthesia and intravenous anesthesia is suitable for many of the requirements of present-day surgery, particularly when a method of inducing anesthesia that carries with it no hazard of fire or explosion is needed. It is suggested that surgeons encourage their anesthetists to try to improve their methods and to visit others who are employing a modern technique and using accepted anesthetic agents.

William F. Rienhoff, Jr., Baltimore, Md.: The Use of Sympathetic Nerve Block Anesthesia in Minimal Resection of the Stomach for Ulcers of the Pyloric Antrum and Duodenum.—A series of cases is reported in which direct injection of the celiac sympathetic plexus with 100 c.c. of 1:3,000 solution of pantocaine has been made previous to a minimal resection of the pyloric antrum and first portion of the duodenum. The advantages of this type of nerve block were discussed: (1) as an adjunct anesthetic; (2) in counteracting operative shock; (3) in preventing postoperative complications. A smooth postoperative course was noted. Hospitalization was shorter.

Discussion of Symposium on Anesthesia: Frank Lahey, Boston, Mass., reported a fatal cyclopropane explosion. In collaboration with one of the staff of the Massachusetts Institute of Technology, Lahey has devised an intercoupling apparatus which would equalize the electrical charge in the gas machine, operating table, etc. This should reduce explosions, but obviously would not eliminate the necessity for extreme caution. Roscoe R. Graham, Toronto, Ont., and co-workers prefer spinal anesthesia in upper abdominal operations. The increased relaxation, etc., has resulted in an increased incidence of stones in the common duct from 10 to 21 per cent of gall-bladder cases. Fraser B. Gurd, Montreal, Que., reported that three years ago he began the use of spinal anesthesia in thoracoplasties. Two deaths in the operating room were reported. Irwin Schmidt, Madison, Wis., agreed that anoxia is very serious and expressed the belief that the complications of anoxia (mental changes, etc.) in patients surviving it are probably frequent and quite serious. Some anesthetic agents are used to a much greater advantage in some hospitals than in others.

Deryl Hart, Durham, N. C., and (by invitation) Randolph Jones, Eliza, Ga.: A Discussion of von Recklinghausen's Disease With the Report of Two Cases Having Unusual Surgical Complications.—A family presenting this disease through four generations was cited. The complications were discussed. In one, mediastinal neurofibromas were successfully removed at operation; in the other, hemorrhage had occurred into the pachydermatocele which was relieved by evacuation of the clot and excision of the greater part of the surrounding tumor. Only seven reports of this condition have been found in the literature.

Loyal Davis and (by invitation) M. Herbert Barker, Chicago, Ill.: Experimental and Clinical Experiences With the Surgical Problem of Hypertension.—In a previous communication the authors defined their conception of the clinical entity, essential hypertension, and outlined a plan of studying patients before and after a bilateral supradiaphragmatic splanchnicectomy. Only those patients with essential hypertension who were proved to be resistant to potassium sulphocyanate therapy were chosen for operation. The operation alone has not produced any

change in the blood chemistry findings, blood pressure, or clinical course of these patients, but in a series of patients has been followed by an increased sensitivity to the effect of potassium sulphocyanate. The physiologic mechanism of this result of splanchnicectomy is as yet unexplained.

In discussion Max Peet, Ann Arbor, Mich., reported that in a series of 194 cases of splanchnicectomy for hypertension, the best results were obtained in the younger patients. Results in general were variable, between 40 and 100 per cent relief from symptoms. Alfred Blalock, Nashville, Tenn., presented some experiments on dogs, indicating that the hypertension produced by the Goldblatt clamp causes a rise for about two weeks and if the second kidney is removed after the hypertension has regressed, a rise in blood pressure again takes place.

Gilbert Horrax and (by invitation) James L. Poppen, Boston, Mass.: *Experiences With the Total and Intracapsular Extirpation of Acoustic Neuromas.*—Operations upon cerebellopontile angle tumors (acoustic neuromas) were accompanied by a prohibitive mortality in the early years of neurosurgery. In 1916 a method for the intracapsular enucleation of these growths was described by Cushing. The mortality was reduced, in his hands, to approximately 10 per cent, and the results in most instances were exceedingly satisfactory for periods from five to twenty-six years as disclosed in a subsequent communication. Most neurosurgeons employed Cushing's method except in occasional cases, but in 1922 Dandy, and more recently Olivecrona (1934), advocated total removal. During the past four years the authors have performed complete acoustic tumor extirpations routinely. From the whole series of thirty-three patients eighteen primary tumors have been wholly removed, with two deaths, a mortality of 11.1 per cent. Because of the high incidence of recurrence after intracapsular extirpation and because the operative mortality in the recurrent group is excessive (33½ per cent), the authors believe that primary complete removal is the procedure of choice.

Francis C. Grant, Philadelphia, Pa.: *Treatment of Cranial Defects by Cranioplasty.*—A series of 50 cases followed from two to twenty years, in which the external table of the skull has been used to repair the defect, was presented. Indications for operation consist of headache, fear of trauma, pain, and cosmetic correction. The author dismissed the use of metal and celluloid, but prefers bone, using ribs in the large defects. Frequently epilepsy present in patients with these defects was benefited by the cranioplasty.

A. A. Zierold, Minneapolis, Minn.: *Gangrene of the Extremity in the Diabetic.*—Spreading gangrene of the extremity in the diabetic, if treated by immediate amputation, is often followed by death or the necessity for secondary amputation due to sepsis or recurrence of gangrene. Spreading moist gangrene is attended by infection which not only causes progression of the gangrene but often renders the underlying diabetes uncontrollable. If treatment is first directed toward control of the infection, the gangrene will be arrested and the diabetes will become more amenable to treatment. Infection may be controlled by local excision of infected and necrotic tissue, followed by hypertonic saline baths. When sepsis and gangrene are arrested, amputation may be undertaken with adequate preparation and a greater degree of safety. Amputation should not be considered a therapeutic procedure. Amputation should be undertaken only as an elective procedure, never as an emergency. Amputation need not be above the level of the upper third of the tibia.

William E. Gallie, Toronto, Ont., stressed the importance of adequate medical care and urged that infection be dealt with as in nondiabetic cases. Leland S. McKittrick, Boston, Mass., reported on experiences with 503 amputations with a

mortality of 12.9 per cent. A follow-up study revealed that only 35 per cent of these patients were living after five years, emphasizing the fact that hospitalization should be made as short as possible. Frank Meleney, New York, N. Y., urged that cultures be made on all cases. Herman E. Pearse, Jr., Rochester, N. Y., called attention to the poor applicability of the term diabetic gangrene, since infection is so frequently the lesion present. Alton Ochsner, New Orleans, La., emphasized that there are certain instances when early amputation is really a life saving procedure, but that unless an amputation is an emergency procedure the determination of the vascular competence by blocking the sympathetic lumbar ganglia with novocain frequently makes it possible to save the extremity.

J. Stewart Rodman and (by invitation) William G. Leaman, Jr., Philadelphia, Pa.: **Circulatory Problems of Surgical Importance in the Diagnosis of Abdominal Lesions.**—Reflex disturbances having the primary seat in the heart (angina pectoris, coronary occlusion, acute pericarditis) and simulating surgical conditions in the abdomen were stressed. Particular reference was made to the differential diagnosis in cardiac cases complicated by actual gall-bladder disease. Arrhythmias and other abnormalities commonly produced in the heart by gall-bladder disease should be borne in mind. Important electrocardiographic patterns of surgical interest were shown. Jaundice occasionally occurs in cardiovascular disease. Hepatic congestion from cardiac failure may simulate gall-bladder disease; embolism causing mesenteric thrombosis may simulate intestinal obstruction; acute pericarditis may even resemble acute appendicitis. Numerous surgical conditions may be simulated by abdominal aortic aneurysm at the time of rupture.

Robert L. Harris, and (by invitation) T. S. Perrett and Angus MacLachlan, Toronto, Ont.: **Fat Embolism—An Important Complication of Fractures and of Operations Upon Bones.**—Fat embolism occurs when free fluid fat enters the veins and is transferred by the blood stream to be deposited as embolic globules in the capillaries of lungs and other organs. This condition most commonly arises as the result of injuries to or operations upon bones. It is not easily recognized since the clinical picture is varied and simulates other and more common conditions. Even at post mortem it may be completely overlooked unless special measures are adopted. The important signs by which it may be recognized were reviewed; viz., fat in urine, fat in sputum, petechial hemorrhages in skin. To these is added a new sign observed in a fatal case; viz., rapid and profound fall in hemoglobin due to the extreme hemorrhagic pulmonary exudate. This may be of diagnostic value in certain cases. Experimental evidence was advanced in an effort to explain some of the obscure features of fatal fat embolism, notably the profound and often fatal effect of comparatively small amounts of fat.

In discussion J. Dewey Bisgard, Omaha, Neb., cited some animal experiments in which the use of ether anesthesia diminished the number of fat emboli following the injection of a suspension of bone marrow fat.

Thomas G. Orr and (by invitation) Ferdinand C. Helwig, Kansas City, Mo.: **Liver Trauma and the Hepatorenal Syndrome.**—Additional cases were reported supporting the traumatic hepatorenal syndrome. Not all of these died. The cardinal manifestations, consisting of albumin in the urine, elevated N.P.N. in the blood, diminished urine output, occasional blood in the urine, and anuria, were reviewed. Pathologically the hepatic cells show necrosis and degeneration throughout large areas. The findings at post mortem show marked tubular degeneration with hemorrhages in isolated areas.

In discussion Warren Cole, Chicago, Ill., presented the clinical and pathologic features of a patient who died following splenectomy, with manifestations typical

of so-called hepatic insufficiency, and in whom there was ante-mortem and post-mortem corroboration of a serious renal lesion. Attention was called to the similarity of the clinical picture in this group of cases to that described in the traumatic hepatorenal syndrome. Fred Coller, Ann Arbor, Mich., called attention to the danger of ascribing the renal lesions in these cases to the liver injury, since so many conditions, including dehydration, infection, fever, etc., might produce them.

Arthur W. Allen, Boston, Mass., and (by invitation) John D. Stewart, Boston, Mass: **Control of the Hemorrhagic Tendency in Obstructive Jaundice by the Use of Vitamin K.**—In studying a group of patients with obstructive jaundice and biliary fistula, marked reduction in plasma prothrombin was found. A rapid and almost invariable improvement followed administration of a mixture of vitamin K (extracted from spinach) and bile salts. A postoperative drop in plasma prothrombin occurred, but, if the intake of the vitamin K mixture was resumed, the fall was transitory. In patients who had not taken vitamin K and were suffering from severe bleeding, plasma prothrombin concentration was always below 45 per cent. Such bleeding could be controlled by giving vitamin K mixture, and at the same time plasma prothrombin rose.

Otto C. Pickhardt and (by invitation) A. Bernhard and Irving Kohn, New York, N. Y.: **The Significance of the Cholesterol Partition of the Blood Serum in Surgery of the Gall Bladder.**—In gall-bladder disease with disturbed hepatic function, a practical test indicating the state of the liver should prove of value in determining expediency of surgical intervention. The ratio between total and free cholesterol appears to be a physiologic constant in normal individuals, the free cholesterol not exceeding 30 per cent of the total cholesterol and the ratio being altered only in infections and disturbed hepatic function. Patients having a normal ratio were considered excellent risks, from the hepatic standpoint; in those with increased percentage of free cholesterol, operative procedures should be delayed until treatment results in return to normal ratio. Patients, when operated upon with increased percentage of free cholesterol, had stormy recoveries or fatal outcome. Determination of the cholesterol partition in gall-bladder disease before and after surgical intervention is advised, since results obtained serve as an aid in the prognosis of disease of the liver and biliary tract.

In discussion, John A. Wolfer, Chicago, Ill., corroborated the value of the test and showed a slide illustrating the value of cholesterol studies, so far as mortality is high in patients who show a rise in the percentage of free cholesterol. Robert L. Payne, Norfolk, Va., reported xanthoprotein studies of the blood, and urine indican as being valuable in predicting mortality.

MEETING OF THE AMERICAN ASSOCIATION FOR THE STUDY OF GOITER

HOWARD MAHORNER, M.D., NEW ORLEANS, LA.
(From the Department of Surgery, School of Medicine, Tulane University,
New Orleans, La.)

THE annual meeting of the American Association for the Study of Goiter was held in Cincinnati, Ohio, May 22, 23, and 24, 1939, at the Netherland Plaza Hotel. Thirty-four scientific papers were presented, thirty-one of which are reviewed herein. The sessions were consistently well attended, and a concentrated three-day discussion of goiter and related diseases was most interesting throughout.

D. U. McGregor, of Hamilton, Ont., reported two cases in which microscopic section of the thyroid gland after thyroidectomy showed lesions which had the microscopic characteristic of tuberculosis. Some authors believe that tuberculosis and hyperthyroidism are rarely seen together while others believe that the majority of cases with hyperthyroidism have incipient tuberculosis. After reporting the cases he concluded that tuberculosis may occur in any type of gland, that it should be considered in a diagnosis, and that the preoperative diagnosis is rare. Tuberculosis may occur in the thyroid when it is not found to be present elsewhere in the body. He believes that histologic examination only can make the diagnosis certain. Subtotal thyroidectomy is the treatment.

Leroy Long, of Oklahoma City, Okla., presented three cases of goiter in siblings. There were six children in the family and three of them had goiter. The onsets of the goiters were at ages 3, 6, and 4 years respectively. Two of the affected children were girls and one was a boy. The goiters were nodular and showed a marked tendency to recur. Tissue showed fetal adenoma with some tendency towards malignancy, particularly in the girls. One child had a thyroidectomy twice before puberty. These children were born in a nonendemic goiter region.

F. B. Dorsey, Keokuk, Ia., president of the society, reviewed the salient features in the history of the organization and its development.

On the morning of the first day, a dry clinic was held by W. A. Plummer, of Rochester, Minn. Two of the interesting cases included, first, a patient who had some signs of hyperthyroidism with marked tachycardia and slight weight loss, but who lacked many of the other evidences of goiter and hyperthyroidism. The case was believed by Dr. Plummer to be one of "an apprehensive state" or "chronic fatigue." One of the other interesting cases presented was a bilateral resection of the thyroid gland. The patient had adequate breathing space, but the submucous resection of the cord. The discussion of this case revealed the prevailing opinion to be that possibly tracheotomy with a permanent tube and valve and with the preservation of the voice is better than any such procedure which permanently destroys the voice. Brien King, Seattle, Wash., in discussing the case, believes that the cordectomies and cordotomies should be discontinued until a newer procedure which he described at this meeting could be proved definitely of value or not.

Ralph Bowers, of New York, N. Y., discussed the surgical problems of the recurrent goiter. Dr. Bowers studied the percentage of recurrence in more than 300 cases operated on for hyperthyroidism at the New York Hospital. Eight

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of so-called hepatic insufficiency, and in whom there was ante-mortem and post-mortem corroboration of a serious renal lesion. Attention was called to the similarity of the clinical picture in this group of cases to that described in the traumatic hepatorenal syndrome. Fred Collier, Ann Arbor, Mich., called attention to the danger of ascribing the renal lesions in these cases to the liver injury, since so many conditions, including dehydration, infection, fever, etc., might produce them.

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some of the evidences of poor risk and reiterated that the basal metabolic rate is not a sure guide to the severity of the intoxication.

Thomas O. Young of Duluth, Minn., read a paper on the surgical treatment of low-grade hyperthyroidism. He emphasized the difficulties in diagnosis and in differentiation between low-grade hyperthyroidism and neurosis. The basal metabolic rate is not entirely reliable, and clinical examination should be the basis of the diagnosis. Thyroidectomy in low-grade hyperthyroidism gives good results.

Elliott Cutler and Stanley Hoerr, of Boston, Mass., discussed avertin anesthesia for thyrotoxicosis. They used avertin anesthesia for thyroidectomy in 66 cases. The dose of avertin was from 60 to 100 mg. per kilogram of body weight. They had hoped that the anesthetic would be one following which the postoperative course would be smoother, that it would prove an ideal anesthetic, alleviating apprehension in toxic cases. Their experience, however, leads them to announce that it is no more desirable as an anesthetic from these standpoints than others, and that the postoperative course is not more smooth.

Howard Mahorner, of Tulane University, New Orleans, La., stated that, whereas goiter is not endemic in the South generally, it is not uncommon in certain localities. The South may be an endemic hypothyroid region. In Louisiana goiter is more prevalent near the lower end of the Mississippi River. He reviewed 248 cases which were admitted in one year to the Charity Hospital. The mortality for goiter in the South, while high in general, is in certain hands no more than it is in the endemic goiter regions where larger numbers are being handled. He showed a case of a child with a huge goiter whom he operated upon at the age of 17 months. The child subsequently developed normally and at the age of 7 years appeared normal.

Brien King, of Seattle, Wash., described a new operation for bilateral abductor cord paralysis. When both recurrent laryngeal nerves are severed, the cords eventually come to rest near the midline, leaving the patient very little air space. Dr. King's operation consists essentially of attaching the upper end of the anterior belly of the omohyoid to the arytenoid cartilage, permitting the muscle on inspiration to draw the arytenoids apart and increase the breathing space. The operation preserves the voice. In certain instances in which the paralysis has been long standing and in which the arytenoids are fixed towards the midline, it is necessary to divide the cricoarytenoid joint capsule and cut the interarytenoid muscle which holds the arytenoid cartilages together by being chronically contracted. He showed moving pictures of the operation and of the larynx of these patients before and after operation. The breathing space was undoubtedly markedly increased and his movies were proof of a brilliant solution of the distressing problem of bilateral cord paralysis. This presentation by Dr. King was awarded honorable mention for the Van Meter Prize. It was clinically the outstanding presentation of the meeting.

Edwin G. Ramsdell, of New York, N. Y., reported four cases of "calcinosis syndrome." The syndrome consists of slight weight loss, a tightness of the skin, and deposits of calcium under the skin and around the joints, particularly around the hip joint. The patients have a stiff feeling and are sometimes unable to bend over properly and pick up objects from the floor. There are no changes in the blood calcium and phosphorus values. Dr. Ramsdell has done a unilateral complete lobectomy and parathyroidectomy in four cases, one of which was reported six years ago. Soon after the operation the patients lose the sensation of stiffness and are able to bend over and to move their facial muscles much better. The subcutaneous calcium deposits disappear. The subjective improvement is marked

surgeons did the thyroidectomies, and the recurrence rate for the surgeons varied from 0 to 14 per cent. He found that the men leaving the least amount of gland had fewer recurrences and usually, when an insufficient amount of tissue was removed, the residual tissue was found to be excessive at the superior pole. He advocated very careful dissection of the superior pole to insure an adequate removal of tissue from that place as well as from elsewhere on the gland.

Cleon A. Nafe, of Indianapolis, Ind., discussed metabolic disturbances following thyroidectomy. He agrees with the general trend to leave less thyroid tissue at the time of thyroidectomy for toxic goiter. In 300 cases the rate of recurrence was 2 per cent. Definite myxedema develops in approximately 1 per cent of cases. Diagnosis of myxedema is sometimes difficult. A second type of hypothyroidism is transient myxedema postoperatively which returns to normal. This comprises approximately 6 per cent of cases, and there is a third type of hypothyroidism with indefinite symptoms, lack of energy being the most dominant complaint. He thinks that the small percentage of recurrence does not justify total thyroidectomy. He showed cases of myxedema and advised against deliberately producing it.

Martin B. Tinker, Jr., of Ithaca, N. Y., showed the incidence of results ten to thirty years after thyroidectomy. Thirty years ago thyroidectomy was not a common procedure, and unilateral lobectomy was frequently the procedure of choice. In patients with unilateral lobectomy 92 per cent returned to normal occupation, 81 per cent had a normal pulse, and 69 per cent were not nervous. In 7 per cent of patients exophthalmos persisted, at least to a certain extent. Bilateral partial resection resulted in 86 per cent returning to their normal occupations. This raises the question of whether bilateral partial resection is so much better operation than unilateral operation as far as permanent results are concerned.

David Berlin and Samuel Gargill, of Boston, Mass., reported fifteen cases of persistent and recurrent thyrotoxicosis and discussed the factors influencing persistence and recurrence. Recurrence of hyperthyroidism is not associated necessarily with a reappearance of palpable thyroid tissue. They think that inadequate thyroidectomy is less a causal factor than emotional strains in recurrent hyperthyroidism. In persistent thyrotoxicosis inadequate thyroidectomy or leaving too much thyroid tissue is the important factor. In 237 cases persistence was found in 2 per cent and recurrence in 3 per cent. Emotional causes, such as fright, worry, and severe mental strain, are generally the causes of recurrences.

Arthur C. Scott, Jr., of Temple, Tex., discussed total thyroidectomy for diffuse toxic goiter. He said that Kocher performed and then abandoned total thyroidectomy because of complications. He added that the present trend is toward the more radical operation. Dr. Scott advocated total thyroidectomy for toxic diffuse goiter. He has performed 71 total thyroidectomies with 2 deaths. Fifteen of these were for recurrent hyperthyroidism. The complications were: 3 cases with tetany, 2 cases with unilateral nerve injury, and 2 cases with bilateral nerve injury. The mortality for subtotal resection in his hands is 0.4 per cent, but he still thinks total thyroidectomy is safe because the deaths and complications resulted in the first cases done by him when he was developing his technique. In 69 cases only 2 patients had persistent hyperthyroidism or recurrent hyperthyroidism. The rest were free of their hyperthyroidism.

W. O. Thompson, of Chicago, Ill., discussed the management of severe thyrotoxicosis by careful preoperative preparation. He showed a reduction in surgical mortality from 10 per cent to 1.6 per cent in the cases he studied. He emphasized

negative. Althausen described a new test based on the acceleration of absorption in hyperthyroid state. Forty grams of galactose is administered in 400 c.c. of water to the fasting patient. Blood specimens are taken before and one-half hour and one hour after the administration of the galactose. The galactose curve in the normal reaches a peak of around 10 mg. per 100 c.c.; whereas, in hyperthyroid state, it rose to approximately 40 mg. per 100 c.c. Dr. Althausen studied the galactose tolerance curve in 130 patients with hyperthyroidism and found that the increase of galactose in the blood was approximately three times as high in the toxic goiter patient as in the normal patient. This test roughly paralleled the basal metabolic rates but had some advantages in doubtful cases over basal metabolic rate determinations. The rate of disappearance of galactose from the blood is normal in the hyperthyroid state, and the galactose curve is abnormally low in myxedema. He also discussed the possible therapeutic application of the experimental findings of acceleration of absorption of certain substances.

At the annual dinner of the Association the attending members of the meeting were greatly entertained by the humorous address by Cincinnati's jovial Mayor the Honorable J. Stewart, and by the highly intellectual dissertation of the Professor of Humanities of the University of Chicago, Dr. G. J. Laing, on "Are Doctors Human?" The conclusions were equivocal.

Arnold Jackson, of the Jackson Clinic, Madison, Wis., discussed thyroidectomy by electrosurgery. He substituted the electrosurgical knife for the scalpel in 1928 and as a consequence has reduced the incidence of postoperative recurrence in exophthalmic goiter from 5 to 1 per cent. He feels this was accomplished because it was possible to resect more thyroid tissue. Hemostasis is better and, with a drier surgical field, thyroidectomy is facilitated. Instead of ligating the smaller vessels, they are coagulated. Less time is required to perform the operation, which may be a factor in bad risk cases. The method is especially valuable in operations for malignancy of the thyroid.

H. J. Perkins, Boston, Mass., reported that the average blood iodine level in a group of patients studied was elevated in hyperthyroidism. To a certain extent, the blood iodine level is an index of hyperthyroidism. He warned that the results must be regarded collectively and that variations occur in the individual case. The blood iodine determination was helpful in studying 235 patients with borderline hyperthyroidism.

W. D. Frazier and R. B. Brown, of the University of Pennsylvania Medical School, Philadelphia, Pa., discussed the use of vitamin B in the management of hyperthyroidism. Previously, McCarrison found that hyperplasia of the thyroid gland resulted in pigeons fed on a diet deficient in vitamin B and that there was some similarity between vitamin B deficiency and hyperthyroidism. The authors studied 138 cases with hyperthyroidism in which, in addition to their usual preoperative preparation, vitamin B was added to the diet. Sixty-six per cent of the vitamin B treated group gained weight. The control patients with hyperthyroidism did not have vitamin B added to the diet and of these only 20 per cent gained weight. Experimentally in rats they found that vitamin B did not prevent the disappearance of glycogen from the liver. Vitamin B had no effect on the postoperative reaction of the patient. Apparently one advantage is to help a greater percentage of patients gain weight prior to operation.

T. C. Davison, of Atlanta, Ga., reported fifteen cases of carcinoma of the thyroid gland. Carcinoma of the thyroid varies in different reports from 1 to 10 per cent of nodular goiters. Metastases are common. Eight of the cases reported by Dr. Davison were living from two to twenty years after operation. He advised removal of discrete adenoma of the thyroid gland as preventive treatment.

and seems to progress over a number of years. One patient operated on six years ago is apparently well. This presentation was most convincing, and the pictures shown demonstrated a marked improvement in his patients.

Harry Friedgood, of Boston, Mass., reported experimental work on the augmentation of thyrotropic hormone activity by adrenalin and pilocarpine. He found that the activation of the thyroid in animals, the result of injection of thyrotropic hormone, was prolonged by the addition of either adrenalin or pilocarpine; that is, where the usual effect of the thyrotropic hormone lasted ten to twelve days, the effect was prolonged to sixteen days. The effect is due to adrenalin. The injection of pilocarpine acts indirectly on the thyrotropic hormone by stimulating the adrenal gland and liberating more adrenalin.

D. Puppel, of Barnes Hospital, St. Louis, Mo., discussed calcium metabolism in diseases of the thyroid. In toxic goiter there is an increase in excretion of calcium and, likewise, an increased excretion of iodine. Prolonged negative calcium balance in hyperthyroidism may result in osteoporosis, but a positive balance of calcium can be maintained if enough calcium is given daily, thus preventing osteoporosis.

J. B. Collip, A. H. Neufeld, and O. F. Denstedt, of McGill University, Montreal, Que., reported further studies on a specific metabolic principle of the pituitary gland. They found a metabolic factor of the pituitary which depressed the respiratory quotient and thus indicated that more fat was being burned. This additional pituitary factor did not demonstrate a refractoriness as is found for thyrotropic hormone; that is, the effect does not disappear after a period of time, but continues indefinitely as long as this pituitary factor is injected. This metabolic factor also had other effects. The muscle glycogen is increased, and the nitrogen in the urine is decreased, indicating that less sugar and proteins are burned, whereas there is an increase in fat metabolism. It inhibits the hyperglycemic action of adrenalin and the hypoglycemic action of insulin.

Elmer C. Bartels, of Boston, Mass., discussed coronary disease in myxedema. In 59 cases of spontaneous myxedema at the Lahey Clinic, all patients were over 20 years of age and the average age was 51 years. There were 15 cases with coronary disease, 13 women and 2 men, indicating that coronary disease is frequently a complication of myxedema. Thyroid extract, as little as $\frac{1}{2}$ gr. daily, in myxedema may produce symptoms of coronary disease. Five of these patients died, 4 of infarction and 1 of heart failure. Myxedema may be a causative agent of coronary disease.

The Van Meter Prize this year was awarded to C. L. Althausen, of the University of California, San Francisco, Calif., for his studies on the influences of the thyroid gland on intestinal absorption. Dr. Althausen named his co-workers: William J. Kerr, J. C. Lockhart, and M. H. Soley. The report of his work was given in four parts. He found that intraperitoneal injection of thyroxin (1/10 mg. per 100 gm. of body weight) in female rats resulted in increased absorption of sugar from the gastrointestinal tract. The absorption of olive oil was not increased. The absorption of alanin, which is representative of a typical amino acid, is greater in the presence of glucose than when glucose is not present. The acceleration of absorption of substances in hyperthyroidism is limited to substances capable of phosphorelation; that is, substances which may enter a combination with phosphoric acid. They found that the absorption of calcium is not increased in hyperthyroid rats and, moreover, that the absorption of calcium is not diminished. There is no increase in the excretion of calcium in hyperthyroid rats, but an abnormally high fecal calcium is possibly accounted for by an increased peristalsis in hyperthyroid state. The time for absorption of calcium is less and calcium metabolism may become

licated that scopolamine is becoming more popular and that it may replace atropine. He had used avertin anesthesia in thyrotoxicosis and advised against using morphine with avertin anesthesia. He found in general that avertin was not a good anesthetic; its disadvantages were increased respiratory depression, increased anoxia, and increase in the pulse rate. He favored ethylene anesthesia over all anesthetics for thyroidectomy.

Lindon Seed and Robbie Brunner, Chicago, Ill., studied the blood pressure and pulse rate changes during thyroidectomy in over 600 cases with varying degrees of toxicity. An effort was made to correlate the changes during operation with the clinical picture. There appears to be a direct relationship between the rise in blood pressure at the time of operation and the degree of toxicity, but the pulse rate elevation during anesthesia is a better index of the prognosis.

H. A. Gamble of Greenville, Miss., discussed carcinoma of the thyroid gland. The malignant papillary cystadenoma is the most common and the most radio-sensitive. It requires radical surgical removal.

Frank Deneen, Bloomington, Ill., has found that the electrocardiogram is a more consistent and permanent record of thyrotoxicosis than any other mechanical aid. Electrocardiogram studies of toxic thyroid patients taken before operation and after operation, whether done in one or two stages, show definite changes and are characterized by the development of the ensuing P Wave before the completion of the preceding T Wave. The tracing does not return to the normal base level. When too much gland has been removed and a hypothyroid condition ensues there is the development of inverted T Wave in Lead 3 which is characteristic also of hypothyroid conditions that are either congenital or acquired without operation. These tracings have been followed over a period of fourteen years and have been found to be of much greater clinical value than the basal metabolic readings.

Lawrence P. Engle, of Kansas City, Mo., discussed progressive postoperative exophthalmos. Thyrotropic hormone is the most potent factor in the production of exophthalmos. Thyroid extracts in large amounts will not produce exophthalmos. Exophthalmos and diffuse toxic goiter are produced by the same agent, but the goiter may be removed and the exophthalmos may progress. Progression results in impairment of vision and ophthalmitis. Hypothyroidism is frequently present when the exophthalmos is progressive. The treatment consists of protecting the eyes by oil, lateral canthotomy, suture of the lids, and, in very severe cases, the Naffziger operation or decompression of the orbit by the intracranial route. He reported 4 cases of severe exophthalmos. There was spontaneous subsidence in 2 cases, in one of which only one eye subsided after the other had to be enucleated because of infection. The Naffziger operation was done in 2 cases with good results. He advocates orbital decompression before the condition has progressed too far.

Perry McCullagh, of Cleveland, Ohio, discussed the clinical observations on the use of dihydrotachysterol (AT-10) in parathyroid tetany. Dihydrotachysterol is closely related to irradiated ergosterol. He studied the effects in 10 cases, 6 of which were discussed. In one case, AT-10 relieved tetany when other measures had failed, but the patient died suddenly soon thereafter. He showed other cases demonstrating that small doses are sufficient and that the drug is very potent as a blood phosphorus depressant and calcium elevator. The initial dose should not be over 2 c.c. daily and the standard dose not over from 0.5 to 0.7 c.c. daily or every other day. Careful checks must be made on the calcium and phosphorus of the blood during administration because the drugs may cause marked hypercalcemia when the clinical condition apparently is satisfactory. In addition to the AT-10, large doses of calcium (over 40 gm.) were given daily.

Leon Bogart, of Flint, Mich., had had 62 patients with "thyroidism" without convincing positive laboratory findings. He discussed the clinical courses in these patients. Although they appeared to be hyperthyroid, the laboratory findings did not show it. Of 28 who did not have thyroidectomy, 5 died a cardiac death. Many of these patients lived an invalid life. Thirty-four were operated on and only 2 of these died a cardiac death. He believes that many patients with symptoms of thyroidism and without laboratory findings to support it are benefited by operation. He also stated that acetylcholine produces an induced iodine response in patients in whom the response to iodine is not already satisfactory.

George Crile, Jr., Cleveland, Ohio, discussed papillary tumors of thyroid and lateral aberrant thyroid origin. At the Crile Clinic there have been 15 cases of papillary adenoma and 20 patients with papillary carcinoma. Of 17 patients with lateral aberrant thyroids, 12 were well for an average of thirty-one months. At operation it is necessary to search carefully for additional lateral aberrant thyroids because they may be multiple in the same individual. In 11 of the 17 cases, the same pathologic process which was found microscopically in the lateral aberrant tissue was also found in the thyroid. The treatment is excision.

Donald Guthrie, Sayre, Pa., discussed the preoperative preparation of the toxic goiter patient. He enumerated the measures for careful preoperative preparation. In certain instances cholesterol determination, hippuric acid tests for liver function, and blood iodine determinations should be made. The percentage of multiple operations need be small.

Warren H. Cole, of the University of Illinois, Chicago, Ill., discussed avertin anesthesia for thyroidectomy. Dr. Cole outlined the qualities desirable for an anesthetic in thyrotoxicosis. Particularly desirable is the quality of not increasing anoxia. He advised suitable premedication to abolish psychic trauma and in-

The Student's Handbook of Surgical Operations. By Sir Frederick Treves. Revised by Cecil P. G. Wakeley. Ed. 6. Paper. Pp. 563, with 246 illustrations. New York, N. Y., 1939, Paul B. Hoeber, Inc. \$5.

The fact that this handbook of surgical operations written by the late Sir Frederick Treves and revised by Mr. Cecil P. G. Wakeley has passed through six editions attests its popularity. About half the manual is devoted to surgery of the arteries, nerves, amputations, and operations on the bones and joints. The number of pages devoted to these subjects may seem out of proportion to the rest of the book, but so well and thoroughly are these conditions discussed that the amount of space seems justified.

Surgeons trained in this country may disagree with several of the advocated procedures. For instance, chloroform is never used as an anesthetic in doing a tracheotomy in young children; Paul tubes are rarely employed in making a colostomy or enterostomy; and the technique for enterostomy, given on page 362, is not only obsolete but also hazardous in that it is impossible to do it aseptically.

The wide range of subjects and the brevity with which they are discussed will appeal to most surgeons. If an attempt had been made to discuss more fully the indications and end results of the various operations, this handbook would be more complete. However, since practically the whole field of surgery is reviewed in 546 pages, the author obviously does not intend this to take the place of a comprehensive text. If the student keeps this in mind, this book will prove to be a helpful outline of surgical technique.

The Clinical Diagnosis of Swellings. By C. E. Corrigan. Cloth. Pp. 313, with 120 illustrations. Baltimore, 1939, William Wood and Company. \$4.

By employing clinical methods and physical signs, the author presents a simple and practical method of investigating swellings. The anatomic and pathologic features of tumors are discussed and the problems of regional diagnosis reviewed. Each chapter is written in outline form. The illustrations, while diagrammatic, are clear. An interesting feature is the interjection of brief biographical notes of famous medical men. An appendix is appended.

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Physical Diagnosis. By Richard C. Cabot and F. Dennette Adams. Ed. 12. Cloth. Pp. 846, with 391 illustrations. Baltimore, 1938, William Wood and Company. \$5.

This book now appears in a much expanded and elaborated form. While this edition still incorporates the basic diagnostic methods, it has been entirely rewritten and revised to include the newer advances made in diagnostic procedures. New chapters and many excellent illustrations have been added in order to bring the material abreast of the times. Symptomatology, physical signs, and clinical entities are discussed and correlated in more detail. Interpretations of physical signs in the light of more recent clinical investigations are noteworthy improvements. The introduction of a chapter in history taking is indeed a valuable addition. In the preparation of this edition, the authors have enlisted the advice and assistance of many outstanding specialists, chiefly from the staff of the Massachusetts General Hospital. By doing this, the authors not only have made the volume more complete, but also have liberally incorporated the views of these men

Book Reviews

The Abnormal in Obstetrics. By Sir Comyns Berkeley and Victor Bonney. Cloth. Pp. 525, with 6 illustrations. Baltimore, 1938, Williams and Wilkins Company. \$6.

The authors present this book for use by those preparing for higher examinations and for specialists or near-specialists. They discuss only the pathologic states and assume a background on the part of the reader. The subject range is wide and in such a small presentation nothing can be discussed exhaustively. The book presents the opinions of the authors in a dogmatic way with little of the reasoning which has led to the conclusions stated. Some of the American work, notably in regard to the toxemias, cardiac disease, and syphilis, has been accepted and shortly, but satisfactorily, treated.

It might be seriously questioned whether the treatment of the subject is adequate for the advanced student, but it presents in a short form the presently held opinions of the authors. Since they stand high in the English obstetrical profession, their opinions are of interest.

Surgical Anatomy. By C. Latimer Callander. With a foreword by Dean Lewis. Ed. 2. Cloth. Pp. 858, with 819 illustrations. Philadelphia, 1939, W. B. Saunders Company. \$10.

The present tendency toward overelaboration and verbosity has been successfully resisted by Dr. Callander in the second edition of his excellent *Surgical Anatomy*. Instead, he has used his critical judgment and has eliminated practically all the irrelevant material from the first edition so that the second volume is shorter by 257 pages, more concise, and more truly a surgical anatomy. The illustrations that are changed have been improved. The volume has become one which both medical students and practitioners can use with facility and profit. The reviewer had a number of criticisms of the first edition but has only praise for this one. It is, at present, the outstanding single volume in the field.

Viaje de un Cirujano. By Conrado Zuckermann. Paper. Pp. 142, with 53 illustrations. Mexico City, Mexico, 1938, Unión Tipográfica Editorial Hispano Americana.

The author, a surgeon of Mexico City, has made several previous visits to various parts of the United States. On his last sojourn, he traveled through the Southwest and Midwest and visited the larger medical institutions in these sections of the country. This 142-page chronicle is a record of his observations and impressions of the surgeons he met and the surgery performed at these various centers. Although critical of some of the work observed, in general his comments are very complimentary. He expresses the opinion that American surgery is characterized by organization, cooperation, boldness, and progressiveness. There are numerous diagrammatic sketches of some of the operative procedures he witnessed.

The Student's Handbook of Surgical Operations. By Sir Frederick Treves. Revised by Cecil P. G. Wakeley. Ed. 6. Paper. Pp. 563, with 246 illustrations. New York, N. Y., 1939, Paul B. Hoeber, Inc. \$5.

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on diagnostic methods and interpretations. While such a procedure may destroy to some extent the individuality of the book, it cannot help but enhance its value to the medical student and practitioner, who at times may not realize that one's personal experience, no matter how thorough and extensive it may be, is not adequate enough to modern-day practice to justly cover the field of physical diagnosis.

A Textbook of Medical Bacteriology. By David L. Belding, and Alice T. Martson, in collaboration with Sanford B. Hooker, Sidney C. Dalrymple, Jose P. Bill, and Matthew A. Derow. Cloth. Pp. 592, with 49 illustrations. New York, N. Y., 1938, D. Appleton-Century Company. \$5.

This *Textbook of Bacteriology* is intended for students interested in the medical sciences. Its purpose is to present a text intermediate between the voluminous reference works and the simple presentations too elementary for medical students. The first section of approximately 125 pages covers the general principles of bacteriology. In this section, as throughout the volume, liberal use has been made of diagrams, charts, and tables to facilitate a clear presentation of the subject matter in the least possible space. The medical section contains a brief introductory chapter on the principles of infection and host resistance. All the important pathogens are included, with presentations of recent developments. The protozoan infections, which are usually presented in textbooks of medical bacteriology, have been omitted. Serologic methods of diagnosis, including agglutination, complement fixation, precipitation, typing of pneumococci, and blood groupings are adequately treated. The subject of immunity is presented as a distinct entity in another section of the volume. The section on immunity is complete and thoroughly up-to-date, although very brief. Such new developments as the M and N factors of blood groups are presented by men who have thorough knowledge of the genetic and immunologic principles involved. A paragraph on the technique of determining these factors would have aided the beginner in gaining a clearer understanding of the subject.

The section on fungous infections is more complete than in most textbooks of bacteriology and is entirely up-to-date in its treatment of classification and nomenclature. Like the rest of the book, this section is highly concentrated. The book contains short chapters on the more important virus diseases, as well as on agricultural, food, and industrial bacteriology. The material is presented in very readable form, and the volume should prove valuable in courses supplemented by lectures and collateral reading.

Clinical Gastroenterology. By Horace Wendell Soper. Pp. 316, with 212 illustrations. St. Louis, 1939, The C. V. Mosby Company. \$6.

This book of some three hundred pages, written with the idea of clarifying a "subject which has become entirely too complex," has much to recommend it. It presents in concrete form the author's opinions regarding diagnosis and treatment of gastrointestinal disorders and is based on long years of clinical experience. The work on diagnosis is particularly good and the reproductions of x-ray findings are superb. In discussing etiology and treatment, there is constant reference to physiologic researches bearing on the subject, and the author's methods of treatment, while at times they may differ from those of other authorities in this field, are always practical and can be counted upon to produce favorable results. This book certainly will be of great help to the general practitioner in his daily practice, to the specialist as a reference work, and to the student in his study of this important branch of internal medicine.

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THE CURABILITY OF CARCINOMA OF THE STOMACH

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THE surgical management of carcinoma of the stomach has improved greatly in recent years. The methods of diagnosis have been perfected. Cancer propaganda has been disseminated so that the public has become cancer conscious. Operative technique has improved and there have been marked advances in preoperative and postoperative care. Despite these encouraging signs which should indicate improved end results in the surgical treatment of cancer of the stomach, it is still true that gastric carcinoma presents the highest death rate and the lowest percentage of five-year cures of any type of malignant disease commonly treated by surgical means. However, surgery alone offers a hope of cure.

Implicated vitally in the mechanism of bodily nutrition, carcinoma involving the stomach tends to throw the patient into the group of poor surgical risks. This is reflected in the high operative mortality following palliative procedures or even simple explorations. Simple exploratory laparotomy for cancer of the stomach has a postoperative mortality of 15.5 per cent in this series of cases while gastroenterostomy, the most common palliative operation, has one of 25 per cent. As Ogilvie¹ suggests, when operating on patients for cancer of the stomach "we are working pretty near the limits of human endurance."

It has seemed important to us to consider these various factors together with their statistical effect on the treatment of carcinoma of the stomach as it has been observed in the Massachusetts General Hospital. This study is based upon the entire group of patients, 691 in all, who entered the Massachusetts General Hospital with this diagnosis in the ten-year period 1927-1936 inclusive. Five-year survival rates are calculated to and including the year 1933. This series will be compared

with that previously reported by Parsons² from this hospital including the years 1922 to 1926.

In any consideration of a large series of cases of gastric neoplasm it is at once apparent that the opportunity given the surgeon for effecting any hope of cure is sharply limited by the natural course of the disease. Thus, as shown in Table I, of a total of 691 cases entering the hospital, 250, or 36 per cent, were either never offered surgery, refused it, or were too far advanced to warrant the risk involved in an exploratory laparotomy. Where operation was advised, about 35 per cent had resectable lesions and about 20 per cent of this group survived five years. To the problem of properly handling the cases once they are exposed to surgery is added the equally important factor of increasing the number of patients who have had an early diagnosis made and who are candidates for radical surgery.

TABLE I

	TOTAL CASES	NO OPER- ATION	EXPLORA- TORY LAPAROTOMY	PALLIA- TIVE OPERATION	SUB- TOTAL RESECTION	TOTAL RESECTION
1927-31	296	115	55	58	68	0
1932-36	395	135	88	69	93	10
Total	691	250	143	127	161	10

Symptoms.—The problem of symptomatology involves the general practitioner and internist to a great, if not greater, extent than the surgeon. Now only 35 per cent of patients suffering from carcinoma of the stomach are able to have a resection performed or attempt at cure made; the progress in the control of cancer of the stomach in the future depends primarily upon increasing this percentage.

The material for study falls naturally into two groups according to the duration of symptoms. Unfortunately the larger group seems to have had symptoms for six months or less. Progressive weakness is the only prodromal sign. The onset of epigastric pain and vomiting indicates obstructive involvement of the pylorus and finally brings the patient to a physician. Until preventive medicine reaches a higher degree of efficiency whereby members of the general public after the age of 40 years receive a periodic x-ray examination of the stomach every six months, hope of progress in the future does not lie in this particular group.

It is true, however, that another large group of patients has digestive unrest for months or years before medical advice is sought. The advent of the radio in every home has placed at the disposal of every patient suffering from "upset stomach" a great variety of stomach sedatives. If the patient has not resorted to home treatment, he has, in most instances, been treated as a patient with probable gastric ulcer for varying periods of time. Obviously, not all gastric ulcers are malignant or

undergo malignant degeneration, but enough gastric carcinomas follow a history of preceding ulcer symptoms to regard all gastric ulcers as potentially malignant. Hampton and Holmes³ have called attention to the frequent association of carcinoma with ulcer in the prepyloric area. Certainly in many cases a surgical operation has been performed for ulcer only to have the pathologist demonstrate malignant change in one area in the specimen. The pathologic department makes it a practice to take multiple sections through any gastric ulcer for this reason.

The observation that small gastric lesions often present distant metastases indicates a latent period in the development of the carcinoma. Epigastric symptoms suggestive of ulcer developing in a patient of middle age should be regarded as of neoplastic origin until the benign character is clearly established. With any change in the character of the symptoms or lack of improvement either clinically or by x-ray examination, carcinoma should be regarded as the probable diagnosis and surgery advised. Certainly the recognition of these early lesions will be necessary to increase the percentage of five-year cures, for it is in just this group that cure should be expected. Our experience is in accord with that of Balfour⁴ who found that 35 per cent of patients who had had symptoms for over twelve months were living five years after resection, while only 25 per cent of those who had symptoms less than six months were living the same length of time.

Diagnosis.—The definitely increased percentage of operability in recent years indicates the fact that the diagnosis of cancer of the stomach is being made earlier. X-ray diagnosis, especially because of the employment of the spot film, has become more accurate in the differentiation of ulcer and cancer. The gastroscope has been of increasing value, especially for lesions in the fundus. With the advent of the peritoneoscope, another aid to diagnosis is presented. On the one hand, many patients with generalized carcinomatosis will be spared an exploratory laparotomy, while others may be made available for surgical treatment by excluding the possibility of numerous liver metastases. The discovery of ascites, extensive liver metastases, generalized carcinomatosis, or pelvic metastases with Krukenberg involvement of the ovaries, indicates that only a palliative operation can be performed. These factors may usually be determined by the peritoneoscope without the risk of an exploratory laparotomy. It is impossible to gain any indication of the possible fixation to the pancreas or liver by this means. The x-ray examination also is unreliable in the determination of fixation. With the practice of removing the entire omentum at the time of gastric resection, the presence of omental metastases visualized through the peritoneoscope cannot be regarded as a contraindication to surgery. On the other hand, metastases to the lung or supraclavicular area contraindicate any extensive procedure.

Preoperative Preparation.—Recent improvement in the preoperative preparation of patients for radical surgery has been definitely more marked than in the operative mortality of all types of operations for gastric cancer. Thus, the mortality for resection has diminished from 38 per cent to 25 per cent, for gastroenterostomy from 35 per cent to 25 per cent, and for exploratory laparotomy from 26 per cent to 15 per cent.

It is obvious that patients with gastric malignancy are cachectic beyond the point of observation. Vitamin deficiencies are frequently observed, and quantitative measure of cevitic acid has shown the remarkably low vitamin C supply that is often present in these patients. Cevitic acid can be brought back to normal within a few days by the proper administration of this vitamin. Wound healing may be influenced by the lowered cevitic acid. Other vitamin deficiencies are in keeping with the ascorbic acid level.

A lowered serum protein is frequently observed and, if uncorrected, may contribute to edema of the stoma and a malfunctioning anastomosis. Transfusions are usually employed to correct this deficiency. A jejunostomy may be done for feeding purposes, but it may need to be maintained for a period of three weeks before complete relief can be expected. Secondary operations on the stoma or the jejunum near it are rarely, if ever, indicated.

Sepsis in the depleted patient increases in frequency as a lethal element as the scope for radical resection widens. Where culture of the gastric contents show beta-hemolytic streptococci, sulfanilamide may be tried. Frequent lavage with instillation of dilute hydrochloric acid has also been used. The value of these procedures is not definitely established, but repeated gastric lavages by means of the Levine tube are of great value in mechanical cleansing of the stomach.

Anesthesia.—Anesthesia is one of the chief factors in the mortality following gastric resection. Just as there are many surgical techniques employed by the various members of the staff of the hospital, so the choice of anesthetic has varied widely. Operations of gastrectomy, either total or subtotal, are followed by an unusually high incidence of pneumonia. The experience at the Massachusetts General Hospital has been chiefly with ether as an anesthetic. Avertin has been used as a basal anesthetic in many cases, but postoperative complications have been more frequent and relaxation has not been adequate. Using an intratracheal tube and ether administered through the closed circuit of the Gwathmey machine, adequate relaxation can be obtained with surprisingly little anesthetic. The average amount of ether used for a gastric resection varies between 1 and 2 ounces.

The routine use of local novocaine infiltration supplemented by the splanchnic block of Finsterer would undoubtedly reduce the postoperative incidence of pneumonia. Unfortunately, the temperament of most

of our patients is such that gas or ether must be used in addition. This combination we believe offers the most satisfactory method.

Spinal anesthesia has not been used to any extent in this hospital for gastric surgery. It is the opinion of our anesthesia department that the relatively high toxicity of nupercaine makes it an undesirable agent, while pontocaine cannot be relied upon to give an anesthesia of adequate duration.

Choice of Operation.—It was a point of interest in comparison between the group of cases reported in 1923 to 1926 and the present group to note the increase in the number of resections that have been done. It was possible to resect 16 per cent of all the cancers of the stomach entering the hospital from 1923 to 1926; this figure has increased to 25 per cent in the present series. However, it is of more practical importance to note the number of operated cases that can be resected. It may be seen from Table II that in the first series 27 per cent of all cases operated upon had a resection performed. This figure has increased to 37 per cent in the last ten years. Despite the increased number of resections, the operative mortality has been greatly lowered in the last five-year period so that in the last five years of this survey it was 25 per cent for all resections. That there is a definite mortality from cancer itself is shown by the fact that the operative mortality following exploratory laparotomy alone for cancer of the stomach has been 15.5 per cent in the last ten years; 20 per cent died of the disease while in the hospital for observation and medical care alone.

Certainly the so-called palliative operations of either anterior or posterior gastroenterostomy have little to recommend them, either from the point of view of longevity or comfort to the patient. The exclusion operation of von Eiselsberg involves a transection of the stomach above the growth, a turning in of the distal portion, and an anastomosis made with the uninvolved portion of the stomach. The advantage of this procedure lies in the fact that it permits a useful and satisfactory termination to a procedure begun with a high hope of cure which has become dissipated as complete fixation has been encountered. Certainly the patients have a greater degree of comfort after this operation than after a gastrojejunostomy. Palliative resections also frequently are done when it is impossible to remove metastatic disease. The removal of the local lesion in these patients provides greater comfort than could be obtained if the growth were left in place.

Resection alone offers hope of increased longevity or cure. Thus, the majority of cases should be considered as possible candidates for resection if the technical difficulties are not insurmountable. Radical surgery is contraindicated if massive metastases are present in the liver, but not if hepatic metastases are solitary or small. Resection is also inadvisable in the presence of ascites, metastatic disease in the supraclavicular area or the lung. Metastases in the pouch of Douglas or Krukenberg's tumors

of the ovary do not contraindicate a palliative resection. Involvement of the pancreas, duodenum, or transverse colon increases the technical difficulties and the question of resection is debatable, although a portion of these structures has frequently been purposely included in the resection when involved. The size of the growth gives no indication as to whether resection is advisable or not. Frequently the larger growths may remain confined to the stomach, while the smaller ones demonstrate distant metastases. The clinical evaluation of nodes about a gastric cancer is notoriously uncertain. Resection should never be abandoned because of the extent of supposed nodal metastases for the nodes may prove to be inflammatory. Likewise, the differentiation of cancer and ulcer at the time of operation may be impossible. It is our impression that resections should always be done in case of doubt. In the prepyloric area resection is always indicated. Gastric resection then should be done where technically possible except in the presence of extensive liver metastases, ascites, or massive involvement of vital structures where radical removal is not feasible.

Mortality.—The immediate operative mortality appears to vary in the five-year periods chosen for comparison as seen in Table II. The most encouraging sign is the improvement observed in the last five years where the mortality has dropped from a high of 43 per cent to the present level of 25 per cent. The reduction in this excessively high mortality rate is the essence of the problem of the surgical management of gastric cancer. Excluding operative mortality, one in three patients who have had a gastric resection for cancer survives five years.

TABLE II

	TOTAL CASES	TOTAL CASES OPERATED UPON	PERCENTAGE OF OPERATED CASES RESECTED	MORTALITY OF RESECTED (%)	FIVE-YEAR CURABILITY (%)*
1922-27	233	139	27	38	20
1927-31	296	181	37	43	21
1932-36	395	260	36	25	

*Includes operative deaths.

Pneumonia claims a third of the operative deaths. The anesthesia problem has been discussed and some degree of improvement may be expected with the wider use of local anesthesia. Special nursing with care directed toward the prevention of pulmonary collapse is of extreme importance. Bronchial aspirations either with a catheter or a bronchoscope may serve to remove mucous plugs before pneumonitis can develop behind them. If pneumonia develops, treatment with sulfa-pyridine or specific pneumococcus serum is indicated.

Peritonitis accounts for another third of the postoperative deaths. This looms high in palliative or extensive resections and will probably never be greatly lowered, due to the infection present in the growth.

The remaining deaths are due to miscellaneous complications. Operative shock, prominent as a cause of death in the early group, has been eliminated in late years by prophylactic transfusions. Pancreatitis occasionally causes death when it is necessary to remove a portion of that viscus. It is surprising that there were no fatal pulmonary emboli in this group.

Five-Year Survival.—The five-year survivals have been calculated through the year 1933. Twenty-one per cent of all patients who underwent resection from 1927 to 1933 survived the five-year period. This is essentially the same percentage that were cured by resection in the earlier study. It is to be noted, however, that, since resectability has increased from 27 per cent to 37 per cent, a much greater number of cures have been obtained. These cases represent 20 five-year survivals, or 4.6 per cent of all cases of carcinoma of the stomach that entered the hospital during that time. This is equivalent to 6 per cent of all cases operated upon. Of the cases that have been followed more than five years, 3 are known to have died of cancer, 1 six years, 1 seven years, and 1 nine years after operation. One patient is living ten years after operation, free of disease; 5, nine years, 2 eight years; and 1, seven years after operation. The others have survived from five to seven years. During this period there have been ten total gastrectomies performed for cancer. The longest period of survival was four years and eight months; death was due to recurrence. Since 1936, 20 additional total gastrectomies have been done in this clinic; these cases have been analyzed by Allen.

Certain interesting features appear in this group of cases. It is possible to divide them roughly into two groups: those who had symptoms longer than one year and those who had symptoms less than six months. Only 25 per cent of the survivors were found in the latter group. There is no significant difference in the ages of the two groups, nor were there any differential symptoms. In other words, rapidly growing cancers of the stomach are rarely cured, while cures are comparatively frequent in patients with long histories. Many of them may have originated from preceding ulcers. There is a definite ulcer story in 6 of the 20, while 4 of this group had prepyloric lesions. By x-ray examination the diagnosis of ulcer was made in 1 case, an equivocal diagnosis of ulcer or cancer in 4 cases, and a diagnosis of cancer in all the remainder.

At the time of operation only one of the involved stomachs had any fixation; this tumor was adherent to both gall bladder and pancreas and there were regional metastases. Of the 20 five-year survivals, 5 had metastatic nodes removed while 15 were free of metastases.

There is a marked difference in the curability of cancer of the stomach depending upon the extent of the disease. We have divided the cases of cancers observed from 1927 to 1933 that were resected into 3 groups. Group A includes those lesions that had no metastases, were

localized in the stomach, and were freely movable. In Group B the growth was still freely movable, but metastases were present in the regional nodes. In Group C the growth was fixed to a neighboring viscus,

CARCINOMA STOMACH - RESECTIONS - M G H - 1927-1933

MOBILE, NO METASTASES (24 CASES)
MOBILE, WITH " (27 ")	- - -
ADHERENT (11 ")	—

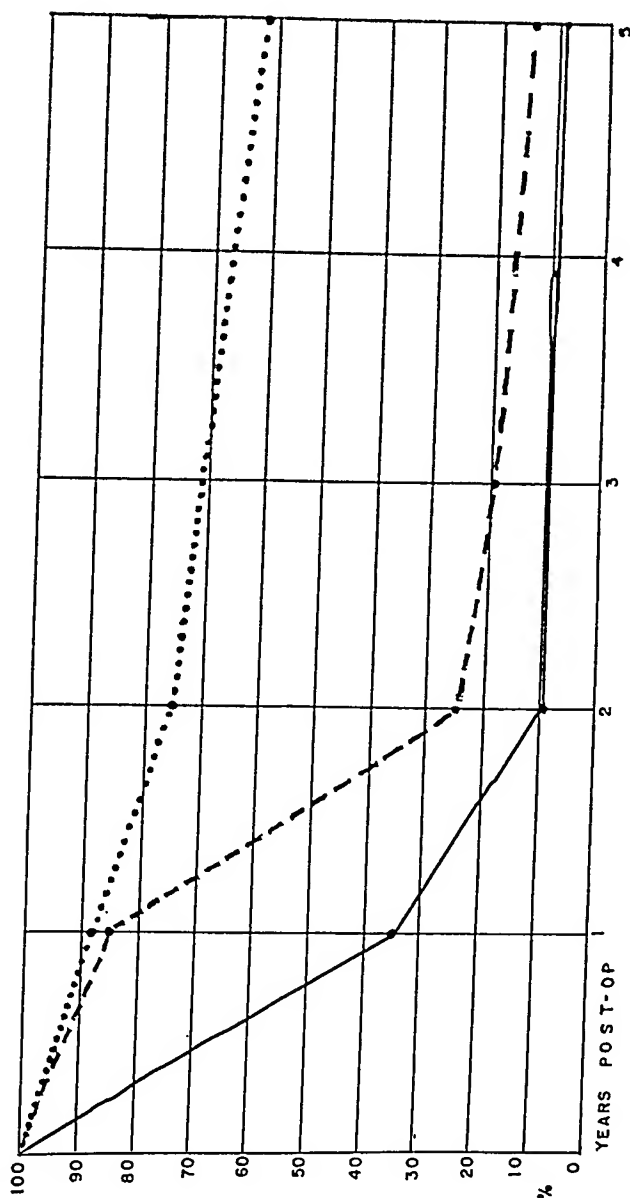


Fig. 1.

usually the pancreas. The survival rate is shown graphically in Fig. 1. Operative deaths are excluded in this graph. It indicates that a patient with a Type A cancer, if he survives the operation, has a 62 per cent

chance of living five years. If regional metastases are present, the chances drop to 18 per cent, while, if fixation is present, less than 10 per cent will survive this period. The importance of resection in early lesions of the stomach is strongly emphasized by these figures.

Ogilvie recently presented his experience with surgery for gastric malignancy as encountered in England in a most interesting diagrammatic form. Since the problem of surgical management of gastric carcinoma is a universal one, it would seem that a comparison of his experience with that of the Massachusetts General Hospital might be enlightening.

To compare our series with that of Ogilvie, Fig. 2 has been prepared. As a matter of convenience, 200 patients have been chosen as an arbitrary number. The ratio of the number of patients subjected to various operative procedures has been calculated in this way. Thus, 177 of our 691 patients, or approximately 50 of 200, had a resection done.

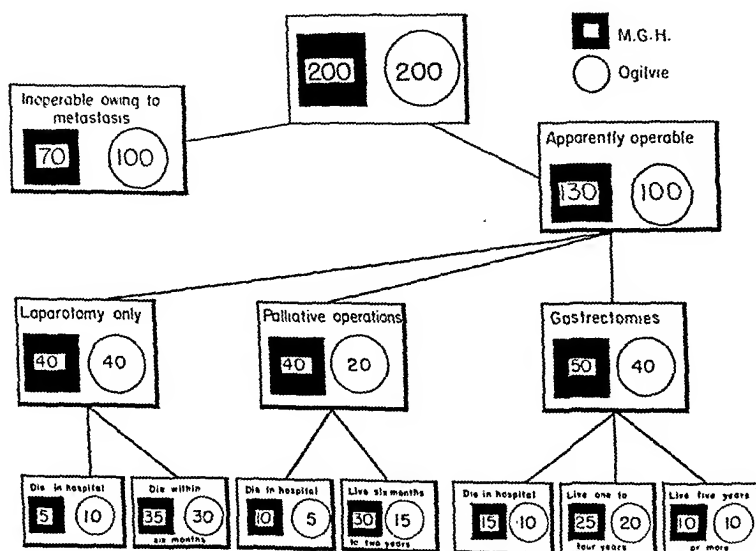
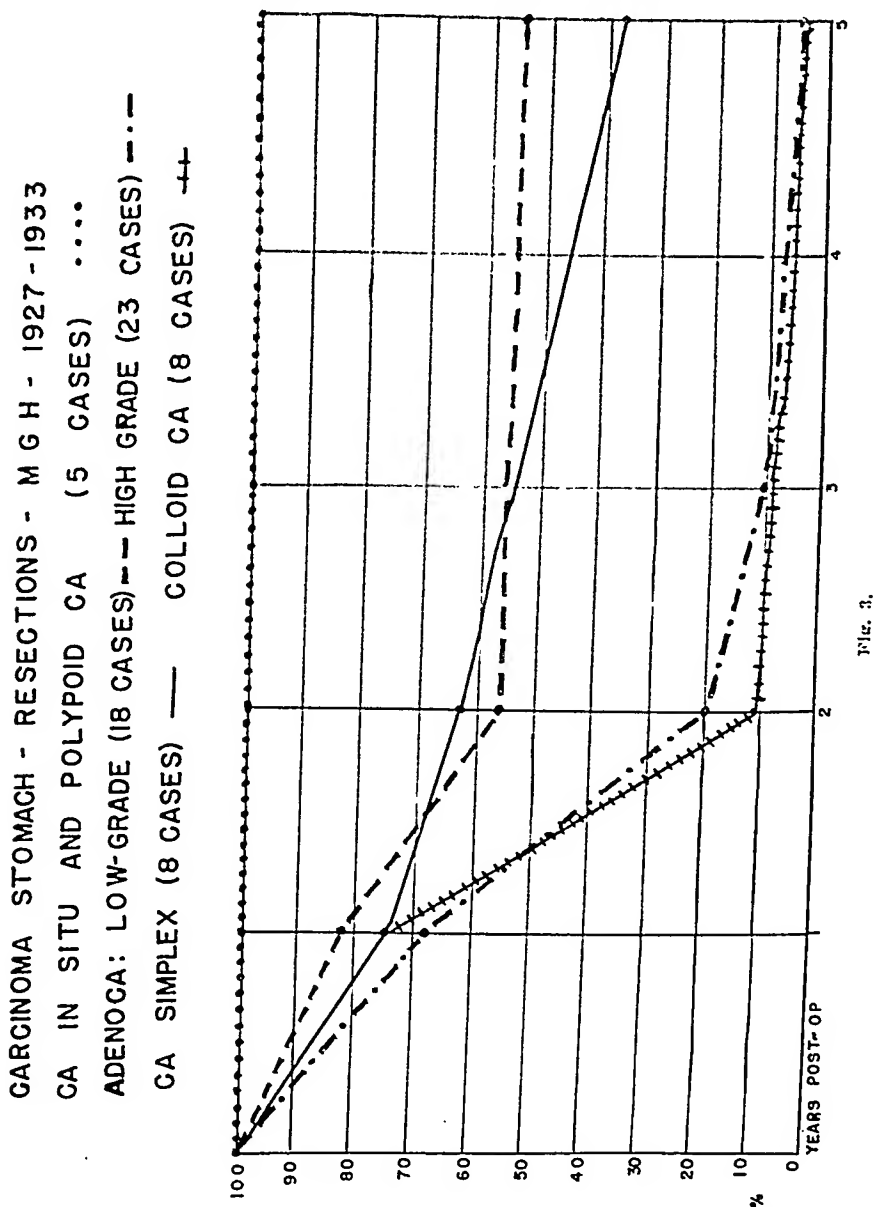


Fig. 2.

It is at once apparent that there is an immediate and appreciable difference in the cases selected as suitable for operation. That Ogilvie has selected well is readily appreciated when at the end of five years the total number of survivors is found to be the same in the two groups, although 30 per cent fewer cases were operated upon in his series.

The essential difference however would appear to be in the attitude taken toward the disease itself. If only those cases are to be chosen for operation with respect to five-year cure, it is reasonable that the indications for operation will be more restrictive. However, if some of the operative procedures, even to the extent of resection, are carried out with the idea of palliation, then of necessity more patients will be

offered operation. That this is apparently the case is made evident by observing twice as many palliative operations in the group from the Massachusetts General Hospital with twice as many survivors from six months



to two years following surgical interference. In the figure representing the number of resections, more resections are done in the Massachusetts General Hospital group with a larger immediate mortality but with

more patients alive one to four years after operation. In percentages the groups are exactly comparable except for a slightly higher immediate mortality in the series from the Massachusetts General Hospital, which possibly may be explained by the attempt to extend the indications for resection on the ground that enough patients are more comfortable after a resection or exclusion operation to justify the slight increase in the immediate operative mortality.

Except for the difference of opinion with respect to the value of palliation, the two sets of figures are astonishingly alike and may be regarded as representative of the problem of gastric carcinoma.

Pathology.—The pathologic sections of all the patients who survived operation, excluding a few slides that have been lost and in which the original report must be accepted, have been reviewed by Dr. Benjamin Castleman. The carcinomas have been divided into several different groups.

The least malignant is the carcinoma in situ. The cells of this tumor are definitely malignant, atypical in appearance, and with many mitoses. There is, however, no evidence of invasion below the basement membrane of the epithelium.

Adenocarcinomas are more malignant. Ranging from polypoid to highly invasive, all these cancers have more or less well differentiated acini. The Grade I adenocarcinoma is often polypoid and nearly as benign as the carcinoma in situ. Adenocarcinomas of Grades II, III, and IV are increasingly malignant.

The carcinoma simplex includes those cancers which are characterized by solid sheets of cells, without formation of acini. In the more malignant types, typical signet-ring cells are found. The colloid cancer is closely related to the signet-cell type; for practical purposes, these may be grouped together.

Review of these sections shows that all cases of carcinoma in situ who survived operation lived over five years. The only adenocarcinomas that lived five years after operation were either polypoid or of Grade I malignancy, with the exception of one Grade III adenocarcinoma. All but one of the cases of colloid cancer were dead before the end of the five-year period.

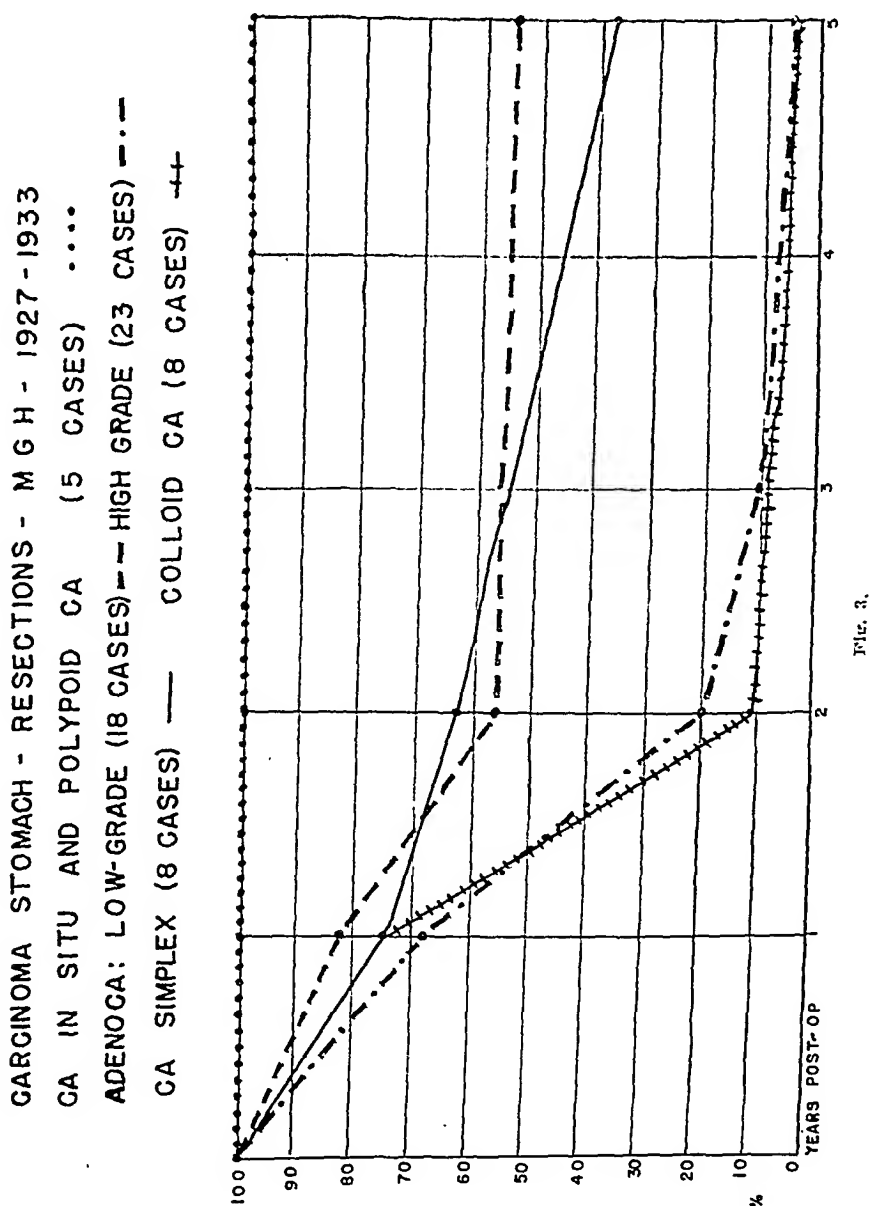
The 20 five-year cures included 3 carcinomas in situ, all prepyloric in location; 2 polypoid carcinomas; 11 adenocarcinomas, all but 1 of low-grade malignancy; and 4 cases of carcinoma simplex. Of the last group 2 are known to have died six and seven years after operation. One had a signet-ring type of carcinoma simplex and is still alive.

The prognosis according to the grade of cancer is graphically represented in Fig. 3.

SUMMARY

The total number of cases of cancer of the stomach that have been recognized has increased greatly in recent years. More patients have

offered operation. That this is apparently the case is made evident by observing twice as many palliative operations in the group from the Massachusetts General Hospital with twice as many survivors from six months



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SUMMARY

The total number of cases of cancer of the stomach that have been recognized has increased greatly in recent years. More patients have

been operated upon and the operability (i.e. resectability) has increased. Meanwhile, the operative mortality has been reduced. The percentage of five-year cures remains at approximately 20 per cent of all cases that have undergone resection, or approximately one-third of the patients who survive the operation. The prognosis is definitely influenced by the presence or absence of metastases and by the pathologic grading of the tumor.

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PULMONARY EMBOLISM

AN EXPERIMENTAL AND CLINICAL STUDY

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PULMONARY embolism is the cause of death in a small, but definite, group of cases. A number of large, collective series have been published; approximately 2 per cent of all deaths have been attributed to it and 6 per cent of postoperative deaths have been reported to be due to pulmonary embolism.¹ We are not concerned here with an analysis of these statistics nor with various efforts to prevent the formation of thromboses leading to a sudden obstruction of the pulmonary artery. An excellent review of the subject with a critical analysis of the clinical problems has been recently prepared by Barnes.¹ Rather, an experimental study has been undertaken here to analyze the mechanisms by which such emboli kill and to place the use of certain methods, which have been used clinically in the treatment of embolism, on a more rational basis.

EXPERIMENTAL STUDIES

The literature on experimental pulmonary embolism is vast and has been summarized in the monograph of Bardin.² Briefly, aqueous and oily suspensions of charcoal, lycopodium, solid masses consisting of fibrin, blood clots, cotton, paraffin, grains of rice, tapioca, starch, beads of enamel, mercury, and many other substances have been placed into a large vein of the animal. Such foreign bodies tend to plug the main artery, the larger branches or the peripheral arteriolar bed, and give rise to different trains of symptoms, depending on the size of the vascular bed which they occlude. Finally, ligatures and clamps producing partial or complete occlusion of the main artery have been applied. The study of Haggart and Walker,³ undertaken in 1923, served as a model for later experiments and placed the amount of constriction necessary to produce death on a quantitative basis (an average of 64 per cent of the main artery). Gibbon and Churchill⁴ pointed out that the experimental occlusion of the main artery corresponds to the syncopal type seen in man, which is characterized by pallor, low blood pressure, and normal oxygen saturation of the peripheral arterial blood; whereas, the

asphyctic type, corresponding to the occlusion of the branches, is recognized by cyanosis, low oxygen saturation of the arterial blood, and a maintained or slightly lowered systemic blood pressure.

Churchill² discussed three possible mechanisms of death following pulmonary embolism; namely, (1) that of complete obstruction of the main artery with immediate death, (2) partial obstruction with delayed death due to reduced effective blood volume, and (3) partial obstruction with delayed death in which right heart failure is a component.

Most of these experiments, however, do not take into account: (1) the factor of anesthesia, which may modify important reflexes from the occluded segment; (2) that ligation of an artery is never comparable to an embolus at the same level; and (3) that the mechanism of death, which has been mostly regarded from a simple mechanical viewpoint, does not explain some of the fatalities in which only parts of the vascular tree are blocked.

In addition to the undoubtedly important mechanical considerations, one must consider certain reflex changes as contributory and occasionally deciding factors in the survival of the patient. In the last few years considerable experimental and clinical evidence has accumulated to show that the pulmonary vascular bed is richly supplied with sensory receptors⁶ and that the pulmonary and bronchial vascular systems possess a strong vasoconstrictor mechanism which is under sympathetic control.⁷ A group of investigators, stimulated by Sauerbruch's⁸ paper before the German Surgical Congress in 1924, spoke of three mechanisms of death; namely, (1) acute asphyxia, (2) gradual right heart failure, and (3) immediate death in shock. This last they regarded as due to a sudden vagal stimulation producing cardiac standstill or coronary constriction. Mosler,⁹ Scherf and Schönbrunner,¹⁰ and Radnai and Mosonyi¹¹ presented electrocardiographic tracings following the production of pulmonary embolism and stated that surgical or pharmacologic block of the vagus improved the tracings and saved a number of animals. All of these authors believe that the pulmonary vagus produces a coronary constriction and thus brings on a syndrome hardly distinguishable from coronary occlusion.

A final group of investigators¹²⁻¹⁴ concerned themselves with the depressor effects of the hypertonus occurring in the pulmonary artery, proximal to the obstruction. That hypertension of the pulmonary artery exists has been registered by Haggart and Walker³ and emphasized by Churchill;⁵ on the clinical side, White¹⁵ has emphasized the acute cor pulmonale, but Schwiegl¹² supplied experimental data to prove that such a hypertonus is capable of initiating depressor reflexes mediated by a receptor mechanism similar to that of the carotid sinus.* His work was partly confirmed by Schweitzer.¹³ This reflex would

*This structure sometimes is referred to as *glomus pulmonum*.⁶

bring about a fall in systemic blood pressure but also a decrease in coronary flow, which, according to Hochrein and Schneyer,¹⁴ might vary in the two coronary arteries; measured with a Stromuhr, coronary constriction was seen more often in the right than the left coronary artery. The anatomic basis for the assumption of such sensory receptors was supplied by Takino and Watanabe.¹⁶ With neurohistologic methods, they showed receptors in the wall of the artery, especially at the insertion of the obliterated ductus Botalli. Stimulation of this segment by the electric current or by distention resulted in a bradycardia and a fall in carotid pressure; when the left depressor or the left vagus nerve was cut, this effect disappeared. Depressor section produced degeneration of the receptors in the ductus Botalli; whereas, vagal section was followed by the degeneration of receptors in the left and right branches of the pulmonary artery.

Villaret, Justin-Besancon, and Bardin¹⁷ are of the opinion that the reflex changes produced by emboli originate in the arteriolar tree and that small multiple emboli are much more dangerous in producing sudden syncope than a massive one. This does not agree with clinical observations.

This brief digest of more recent work on pulmonary embolism permits a well-grounded suspicion that not all patients die of the purely mechanical effects of a massive pulmonary block with a consequent right heart failure, diminution of cardiac output, and lack of circulating blood volume. It was our purpose in this study to (1) produce fatal pulmonary embolism of the massive and the multiple peripheral types in the experimental animal, (2) to find, if possible, certain measures which would protect the animals from death in at least a certain percentage of cases, and (3) to examine the possibility of clinical application. Studies of other angles of the problem are also in progress and will be reported later.

METHODS OF EXPERIMENTATION

After preliminary trials with pearl beads, B.B. shots, blood clots and wool threads, finally two methods were adopted, one to produce a multiple precapillary type and a second to produce a massive type of pulmonary embolism.

In the first group of thirty-five rabbits an emulsion of potato starch was injected into the central vein of the ear, using the method suggested by Dunn.¹⁸ His solution was modified in that 8 gm. of starch shaken up with 17 c.c. of water seemed a suitable emulsion which could be readily injected and which produced death within five minutes in every case. The symptoms preceding death in order of their appearance were (1) dyspnea, (2) cyanosis, and (3) convulsions. The minimum

of them in the wall of the alveoli. They were readily identified by the starch-iodine reaction. The size of the granules varied from 50 to 150 microns, thus corresponding to the size of the arterioles. Distal to the multiple plugs, the capillaries were filled with blood, and free blood was seen in the alveoli and the smaller bronchi. The trachea and larger bronchi were filled with bloody mucus. There was evidence of interstitial edema and hemorrhage. (Fig. 1.)

As it was felt that the size of the starch granules was variable and might not always give the identical amount of arteriolar obstruction, a 1 per cent aqueous emulsion of lycopodium spores was injected in another series of rabbits. The size of the spore was quite constant, between 40 and 60 microns, thus producing a precapillary plug. It took from 10 to 15 c.c. of this solution to produce death within a short time and the solution was difficult to inject.

The embolism produced with potato starch simulated the peripheral, precapillary type of embolism. Its main symptoms were cyanosis and dyspnea. As shown previously by Dunn¹⁸ and Singh,¹⁹ the dyspnea is not due to oxygen want or to the irritating action of the embolic material; or, as Binger, Boyd, and Moore²⁰ believe, to the chemical changes in the blood or to the rise in pulmonary pressure. Harrison and his co-workers have pointed out, however, that the pulmonary afferent fibers of the vagus nerve are extremely sensitive to pulmonary congestion.^{21, 22} In a second series of ten rabbits, gr. $\frac{1}{6}$ of atropine was given intravenously just before the injection of starch. The atropine did not protect these animals from death, but the dyspnea was absent and the bronchial tree was remarkably free from mucus.

In a third series of ten rabbits, oxygen was administered by tracheal intubation. This procedure also reduced the dyspnea and protected the whole series from death when the 2 c.c. dose was given. It was necessary to give a 4 c.c. dose to produce fatality in every instance.

While systemic venous and arterial pressures were not measured in every experiment, the few measurements obtained showed that they were essentially unchanged.

In a final series of ten rabbits, drugs were used which are known to be bronchial dilators, as a bronchial spasm was shown to be present

TABLE I
RESULTS OBTAINED FOLLOWING PRODUCTION OF PERIPHERAL TYPE OF
PULMONARY EMBOLISM

SERIES	NUMBER OF ANIMALS	LETHAL DOSE	MEDICATION	REMARKS
1	35	2 c.c.	None	Dyspnea, cyanosis
2	10	2 c.c.	Atropine	Dyspnea relieved but all died
3	10	4 c.c.	Oxygen	Dyspnea and cyanosis reduced
4	10	2 c.c.	Epinephrine	Pulmonary edema
5	10	2 c.c.	Papaverine	Bronchi free; sedation marked

in Singh's experiments.¹⁹ Adrenaline, amylnitrite, sodium nitrite, and papaverine were used. They were unable to protect the animal from death in the dosage employed; the bronchi were free, but pulmonary edema was especially marked after the use of epinephrine. This has been previously noted by a number of observers²³ (Table I).

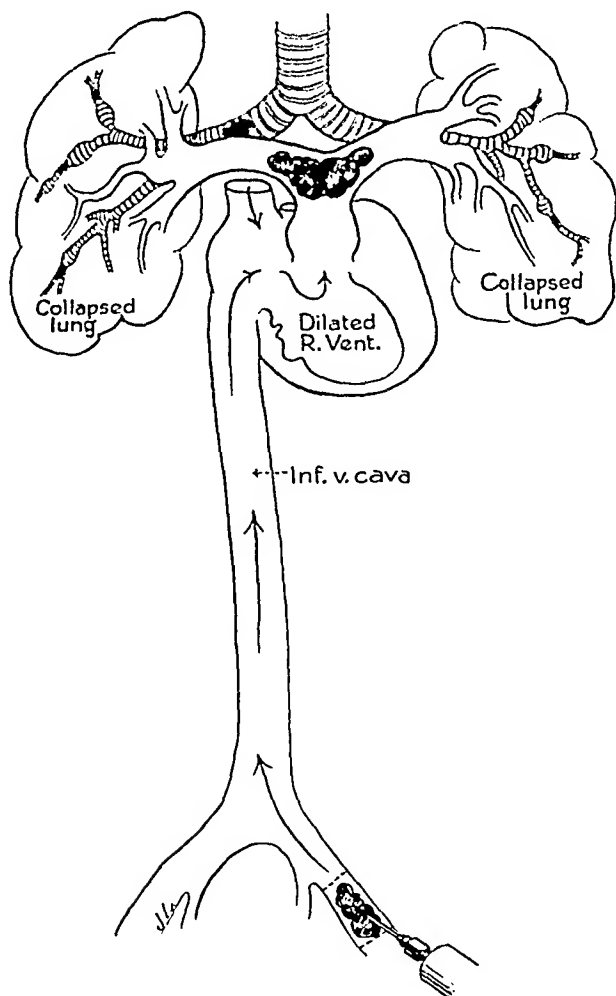


Fig. 2.—Diagram of experimental pulmonary embolism produced with Martin's solution and causing a massive plug in the main pulmonary artery. Note the "cor pulmonale," the dilatation of the right breast, and the multiple plugs in the bronchial tree. The lungs are more often collapsed and atelectatic, but may be edematous. Death occurs suddenly with a marked fall in blood pressure, pallor, and hardly any cyanosis. This corresponds to the syncopal type of embolism.

In the second group, dogs were employed and to simulate massive pulmonary embolism the solution of Martin was used.²⁴ An emulsion of iron perchloride, 1 part; normal salt solution, 1 part; and barium sulfate, 15 parts, was the original formula. This we have gradually

changed to 3 equal parts of the ingredients, as the emulsion was easier to inject and we were not interested in visualizing the clots by x-ray, except in a few instances. The femoral vein was exposed at Poupart's ligament for a length of about 1 cm.; it was compressed proximally while the emulsion was injected and the compression was maintained for fifteen seconds, after which it was suddenly released. The embolus was then exactly the length and width of the exposed venous segment and only seldom grew by apposition. In the small dog it corresponded to the size of the pulmonary artery. It could be readily distinguished from post-mortem clots by its gritty, granular appearance due to the barium (Fig. 2). If it was kept in contact with the femoral vein for longer than twenty seconds, parts of it might firmly adhere to the wall of the vein and the emboli were not of uniform size.

A series of twenty-five dogs, weighing less than 12 kg., all died within a few seconds to less than five minutes, when 2 c.c. of the emulsion were injected. Death occurred with extreme pallor, hardly any cyanosis, but again marked dyspnea. In the few instances in which blood pressures were taken from the carotid artery, the pressures fell very rapidly; whereas, venous pressure rose. This obviously was the type described by Sauerbruch, Rochet, Gibbon, and Churchill as the syncopal type of embolism. On autopsy the plug was in the main pulmonary artery or its major branches. The right heart was markedly distended and pulmonary hypertension was obvious. X-rays of the heart obtained before and after embolism illustrated the sudden dilatation of the right heart.

In a second series of twenty-five dogs, gr. $\frac{1}{8}$ of atropine was injected intravenously a few minutes prior to the production of the embolus. Seventeen out of the twenty-five dogs survived more than ten minutes, some of them living from two to twenty-four hours.

Ten dogs were prepared by bilateral vagal section prior to the injection of the femoral vein, and four out of the ten survived for several hours. This series, however, is too small to permit any conclusions.

Dogs treated with sodium nitrite or with adrenaline all died. The dogs receiving 1 c.c. of adrenaline intravenously showed a marked pulmonary edema with a frothy mucus pouring out of their mouths and nostrils. Papaverine saved over one-half of the animals; its sedative action was marked (Table II).

TABLE II
RESULTS OBTAINED FOLLOWING MASSIVE TYPE OF PULMONARY EMBOLISM

SERIES	NUMBER OF ANIMALS	PREVENTION	FATALITY	REMARKS
1	25	None	100%	Pallor, syncope, dyspnea
2	25	Atropine	32%	
3	10	Vagotomy	60%	
4	10	Epinephrine	100%	Marked pulmonary edema Sedation marked
5	10	Papaverine	40%	

ELECTROCARDIOGRAPHIC FINDINGS

Continuous electrocardiograms are available in fifteen of the experiments. In all cases the tracings were made with the dogs lying in the same position and no alteration was made in the electrodes. The tracings arranged themselves generally into four groups, as follows: (1)

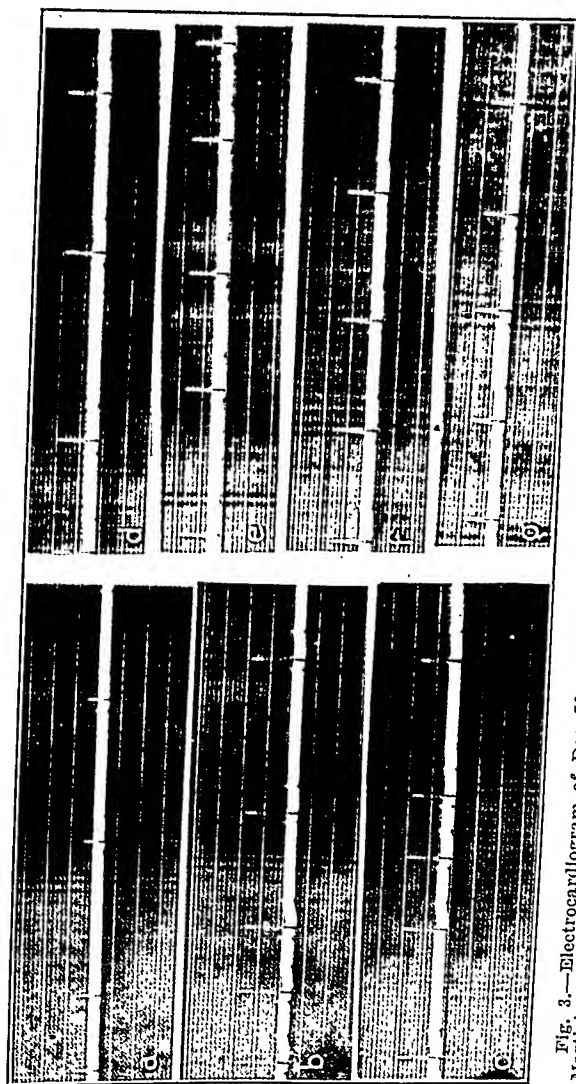


Fig. 3.—Electrocardiogram of Dog 70 weighing twenty pounds. . Two and one-half cubic centimeters of Martin's solution were given. There were no clinical or electrocardiographic changes during the following twenty minutes. *a*, Control Lead I; *b*, control Lead II; *c*, control Lead III; *d*, Lead II immediately following 2.5 c.c. of Martin's solution; *e*, Lead II five minutes later; *f*, Lead II ten minutes later; and *g*, Lead II twenty minutes later.

no clinical symptoms and no electrocardiographic changes; (2) no clinical symptoms but slight electrocardiographic changes; (3) marked electrocardiographic changes followed by death; (4) marked electrocardiographic changes followed by recovery.

Fig. 3 represents an example of the first group. Dog 70 received 2.5 c.c. of Martin's solution and there were no clinical or electrocardiographic changes during the following twenty minutes.

Fig. 4 represents an example of the second group. Dog 35 received 1 c.c. of Martin's solution without clinical or electrocardiographic symptoms, but following the injection of a second c.c. of the solution there was a definite inversion of the T-wave, although clinical signs were still absent.

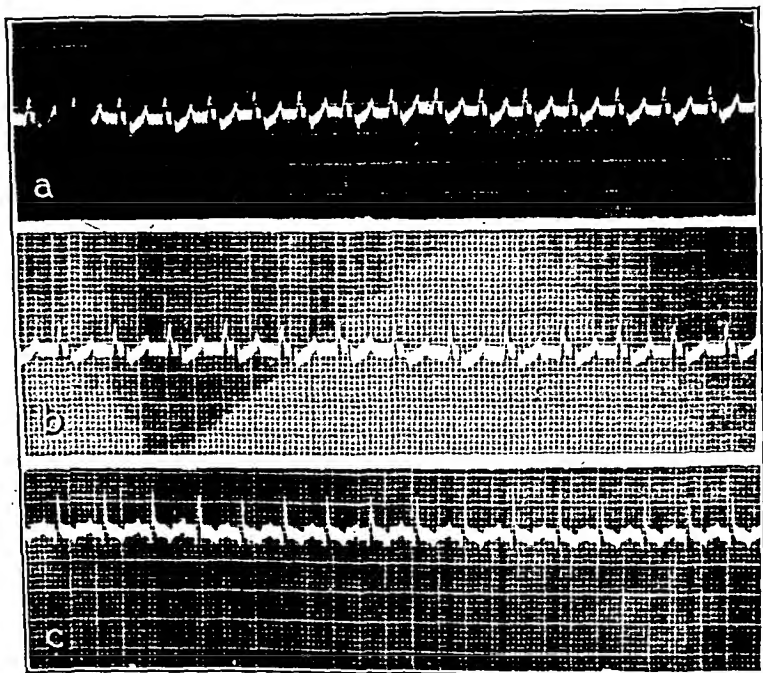


Fig. 4.—Dog 35 received 1 c.c. of Martin's solution into the femoral vein without any clinical symptoms or changes in the electrocardiogram; following the injection of the second c.c., there was a definite inversion of the T-wave, although clinical signs were absent. *a*, Lead II, control; *b*, Lead II after 1 c.c. of Martin's solution; and *c*, Lead II after 2 c.c. of Martin's solution.

In Groups 3 and 4 marked electrocardiographic changes occurred and these changes arranged themselves in the same general pattern. First, there was aberration of the S-T segment, either elevation or depression. This was followed by a slowing of the heart rate with a change in rhythm. These rhythm changes included nodal rhythm, partial A-V dissociation, complete dissociation, and idioventricular rhythm.

Dog 27 represents an example of the third group (Fig. 5). Within a few seconds following the injection of 2 c.c. of the iron chloride, the pacemaker appeared to be dislocated into the A-V node and there was marked depression of the S-T segment. Twenty seconds later an abrupt cardiac standstill appeared which persisted for about thirty seconds. Cardiac action reappeared with the pacemaker still in the A-V node and the S-T segment still markedly depressed. From this

point on, it seems impossible to interpret accurately the mechanism through its rapid changes. It seems most likely that the pacemaker remained at or near the A-V node and continued thus until the dog died a few seconds later. It is possible that there was a short period of idioventricular rhythm with retrograde conduction for a period of about 20 seconds.

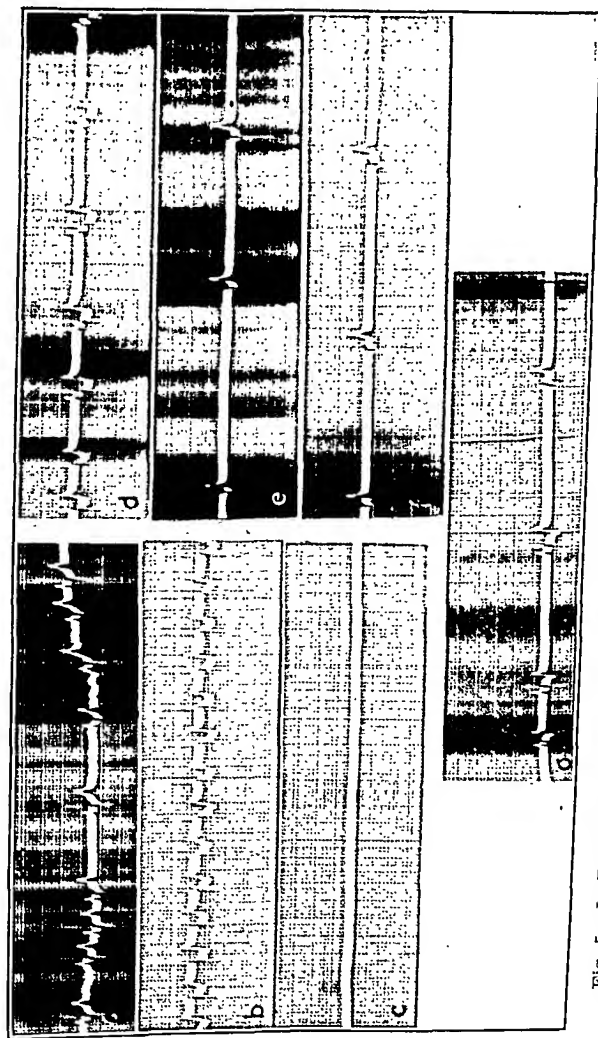


Fig. 5.—In Dog 27, within a few seconds following the injection of 2 c.c. of the iron-barium solution, the pacemaker appears to be dislocated into the A-V node and there is marked depression of the S-T segment. Twenty seconds later an abrupt cardiac standstill appeared and persisted for about thirty seconds. Cardiac action reappeared with the pacemaker still in the A-V node and the S-T segment still markedly depressed. From this point on, it seems impossible to accurately interpret the mechanism through its rapid changes. *a*, Lead II, control; *b*, Lead II immediately after 2 c.c. of Martin's solution; nodal rhythm with marked depression of S-T segment; *c*, Lead II twenty seconds later; complete cardiac standstill; *d*, Lead II ten seconds later; recovery, first in A-V node and later in S-A node; *e*, Lead II twenty seconds later; idioventricular rhythm; *f*, Lead II ten seconds later; and then back to idioventricular rhythm with auricular responses; *g*, Lead II ten seconds later; return to S-A rhythm and then back to idioventricular rhythm; later cardiac standstill and death.

Fig. 6, Dog 28, represents a similar series of events, but with recovery. Immediately following the injection of the solution, a marked nodal tachycardia appeared, accompanied by retrograde conduction and elevation of the S-T segment. Atropine, gr. $\frac{1}{6}$, was given; idioventricular rhythm and five seconds later a cardiac standstill occurred. This persisted for about eighteen seconds and cardiac activity began once more

with idioventricular rhythm. Thirty-three seconds later the auricular complexes reappeared but complete dissociation persisted. After a second injection of atropine, the rhythm changed to a high degree of partial block. With succeeding tracings, sinus rhythm was established with all beats conducted and the dog recovered.

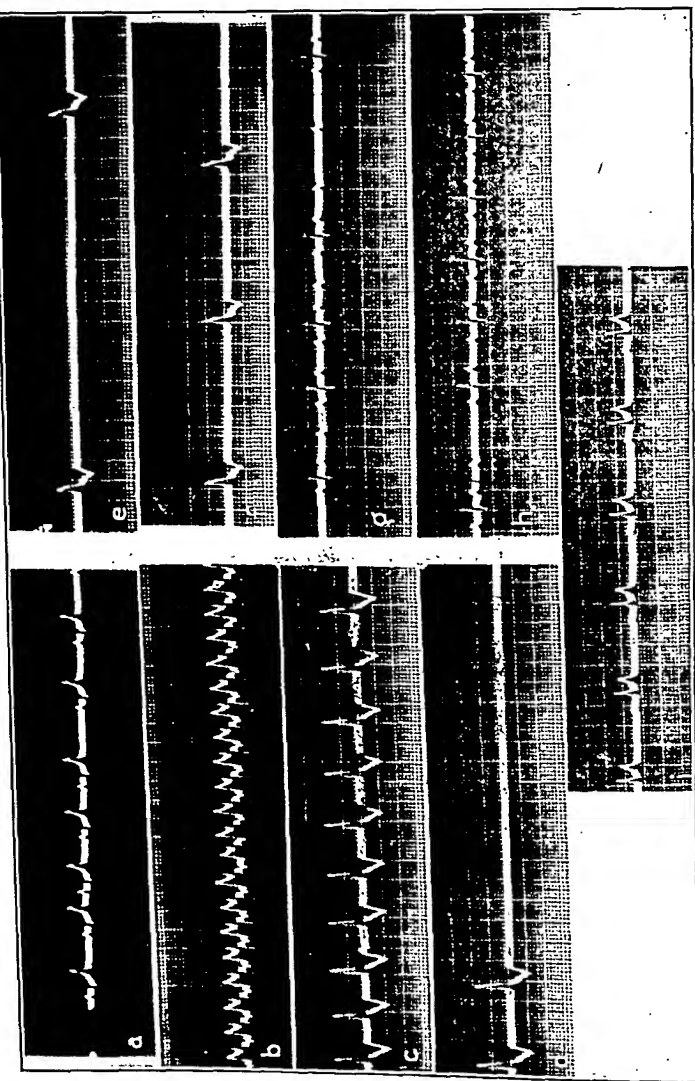


Fig. 6.—Dog 28 represents a similar series of events as those shown in Fig. 5, but with recovery. Immediately following the injection, a marked nodal tachycardia, retrograde conduction, and elevation of the S-T segment appeared. Atropine, gr. 1/6, was given intravenously. Idioventricular rhythm and, five seconds later, a cardiac standstill occurred. This persisted for about eighteen seconds and cardiac activity began once more with idioventricular rhythm. Thirty seconds later the auricular complexes reappeared, but complete dissociation persisted. After a second injection of atropine the rhythm changed to a high degree of partial block. With succeeding tracings, sinus rhythm was established with all beats conducted. The dog recovered. *a*, Control; *b*, immediately after 1.5 c.c. of Martin's solution; nodal rhythm with marked elevation of the S-T segment; *c*, 10 seconds later; idioventricular rhythm; atropine, gr. 1/6, given; *d*, 5 seconds later; cardiac standstill; *e*, 18 seconds later; recovery; idioventricular rhythm; *f*, 33 seconds later; idioventricular rhythm; auricular complexes reappear; *g*, 20 seconds later; S-A rhythm with high degree of A-V block; *h*, 20 seconds later; S-A rhythm with lesser degree of A-V block; second dose of atropine, gr. 1/6, given; *i*, 2 minutes later; S-A rhythm with elevation of the S-T segment; third dose of atropine, gr. 1/6, given, 1/2 minute preceding this tracing; *j*, dog recovered.

COMMENT

In this group of experiments no attempt was made to study systemic and pulmonary blood pressures, blood gases, or to determine coronary blood flow, although occasionally we have made such determinations. These determinations would not be available in clinical cases. Rather we wished to test some simple clinical methods as to their efficacy in

preventing death. In the asphyctic type of embolism, brought about by multiple military emboli, oxygen inhalations were definitely protective. Contrary to the statement of Villaret, Justin-Besancon, and Bardin,¹⁷ these peripheral emboli were not initiating any important depressor reflexes which might be suppressed by atropine, as atropine is not protective in this series, except that it inhibits dyspnea. Whether dyspnea is a useful or useless mechanism here cannot be stated with certainty, but its suppression by atropine is definite.^{21, 22} To relieve the bronchial spasm, which no doubt adds to the difficulty of free respiration, epinephrine or ephedrine seems logical. Papaverine acts directly on smooth muscle; its action on bronchial musculature has been shown by Macht²³ and on the coronary circulation by Rössler.²⁵ Papaverine seemed to be superior to epinephrine or ephedrine, as it does not raise the pressure in the pulmonary artery and is known to relax smooth muscle of the vessels and bronchi; nor does it produce an undesirable fall in systemic blood pressure as the nitrites do.

Atropine, on the other hand, is our most effective inhibitor of vagal and depressor reflexes; it furthermore stimulates the respiratory center, which may be insufficiently oxygenated during the syncopal attack of pulmonary embolism. Its action on smooth muscle must be slight. Oxygen inhalations naturally combat cyanosis and raise the low oxygen saturation of the arterial blood. Adrenaline and neosynephrine, while they may suddenly raise the low systemic blood pressure, do more harm than good in our opinion. Epinephrine caused marked pulmonary edema by increasing pressure in the pulmonary artery²⁶ and by increasing sympathetic vasoconstriction of the pulmonary vascular bed;⁷ neosynephrine has a strong vagal action and is capable of producing a partial heart block in individuals whose vagal endings are sensitized;²⁷ this drug, together with digitalis and strophanthin, may well increase the vagal tone, which we are trying to suppress with atropine.

Venesection, in the absence of shock, has been suggested by White^{15, 28} and practiced by some French authors to relieve the acute cor pulmonale; it is true that it might relieve the distention of the right heart temporarily, but it might precipitate the impending shock; it would not relieve the obstruction and the same pressure would be built up again as long as the right heart is capable of contracting.²⁹ The fall in systemic blood pressure is one of the mechanisms which spares the right heart from overdistention¹² and within certain limits (perhaps to 70 or 80 mm. of mercury) need not be treated.

It seems to us that any procedure which would diminish the increased blood pressure in the pulmonary artery should be helpful in combating death from pulmonary embolism. Of papaverine, we know it relaxes smooth muscle and it has been found to release vascular spasm in peripheral arteries; it has been found helpful in the bronchial spasm of asthmatics and there is some evidence of bronchial spasm in pul-

monary embolism.¹⁹ Atropine decreases the depressor reflexes originating from the pulmonary hypertonus and also decreases dyspnea. The combination of these drugs should be helpful in certain cases of pulmonary embolism.

The interpretation of the electrocardiographic findings is difficult. It will be noted that Lead II of the electrocardiogram was used to follow the changes. All of the small dogs receiving adequate doses of Martin's solution died within a few seconds to five minutes unless they were protected with atropine. In an effort to obtain an almost continuous tracing from the time of injection until death or obvious survival, the single lead was used. It is possible that more accurate information might be gained by including additional leads, and such observations are being carried on in an additional series of experiments.

From the present series of experiments it is impossible to say without argument just what produced the electrocardiographic changes. The type of curve produced is that which is consistent with interference with the coronary circulation. If we assume this hypothesis to be true, we are still unable to say just what produced such interference. Three possibilities immediately suggest themselves. First, a reflex vagal inhibition of the heart; and second, peripheral vascular collapse arising from the pulmonary hypertension through the depressor nerve. There can be no doubt that peripheral vascular collapse occurred in many of the animals, as is shown by the rapidly falling systolic blood pressure. This depressor effect from the pulmonary artery must predominate over the reflexes from the right auricle, carotid sinus, and aorta, all of which would tend to oppose the fall in blood pressure. Whether this collapse was a primary affair or whether it was consequent upon decreased coronary flow cannot be determined from these experiments. The third possibility is acute right ventricular failure due to mechanical interference with the pulmonary circulation which again obviously interferes with coronary flow.

In considering all of these possibilities, the first holds out the most attractive features. Electrocardiographic changes occurred in some animals that showed no sign of shock or of right ventricular failure (Fig. 4). That changes in intrapleural pressure,²¹ in intrapulmonic pressure,^{30, 31} and in pressure of the pulmonary artery^{12, 13} elicit depressor reflexes is well established. A combination of the first two mechanisms must be seriously considered. The purely mechanical effect of the dilatation of the right heart as the cause of the electrocardiographic changes has been brought forward by White¹⁵ and Love, Brugher, and Winslow.³² Measurement of the coronary flow is now being carried out and may throw some light upon this question.

That profound vagal stimulation took place seems clearly indicated by the rhythm changes. Dislocation of the pacemaker from the sinus node, A-V rhythm, partial block, complete dissociation, and complete

suppression of the auricle with idioventricular rhythm are all indicative of strong vagal effects.

In addition, it will be noted that all of the untreated dogs that received effective doses of Martin's solution alone died rather promptly. Many of those receiving effective doses of this solution plus atropine survived. The electrocardiographic changes shown in Fig. 6 immediately following the production of the embolus were quite comparable to those in Fig. 5. After the administration of a considerable dose of atropine, these changes were reversed and passed by steps back to a normal sinus rhythm, although the coronary type of curve still persisted.

This work was completed when the interesting study of Love, Brugher, and Winslow appeared.³² They used clotted blood, colored with India ink, to produce pulmonary embolism in the animal and came to the conclusion that the changes in the electrocardiogram observed after pulmonary embolism are due to dilatation of the right ventricle and that the changes are essentially the depression of the S-T segments in one or more leads. This was found to be true most often in Lead II and often the reversal of the direction of the T-waves in Lead III and the precordial lead were observed. They felt that myocardial anoxemia or reflexes mediated through the autonomic nervous system play no role in the production of the electrocardiographic changes. The depression of the S-T segment was also produced on ligating the pulmonary artery, but not following hemorrhage, shock, or coronary injury. Love, Brugher, and Winslow quote one vagal section experiment in confirmation of their belief, which does not inhibit widespread axon reflexes within the vagal distribution. The existence of these has been suggested by O'Shaughnessy⁴⁶ and Hochrein and Sehneyer.¹⁴

CLINICAL APPLICATION OF RESULTS

In trying to apply the experimental observations in the treatment of pulmonary embolism, two questions immediately present themselves: (1) how accurate is the diagnosis of pulmonary embolism and (2) is there time enough between the onset of clinical symptoms and death to utilize some of the procedures tested in the animal?

Nygaard³³ has made a searching inquiry of the material which came to autopsy at the Mayo Clinic from 1921 to 1933. Of 289 cases of death due to postoperative pulmonary embolism, a correct diagnosis has been made in 82.35 per cent, while the diagnosis was missed in 17.65 per cent. In these 51 cases the causes of death in order of frequency were (1) cardiac failure and coronary occlusion, (2) indeterminate diagnosis, (3) shock and hemorrhage, (4) peritonitis, (5) pulmonary edema, (6) coma, (7) cerebrovascular accidents, and (8) other conditions. It is obvious that the smaller emboli will give a more confusing picture than the massive embolus obstructing both pulmonary arteries.

Statistics giving the reverse side of the picture, namely, the percentage of pulmonary emboli causing death but erroneously diagnosed, are more difficult to obtain. But it is well known that the cause of death from pulmonary embolism, as determined at post mortem, is from 2 to 6 per cent; whereas, the clinical diagnosis of pulmonary embolism, especially in the nonsurgical cases, is much lower. One then has to study the hospital records for early signs and symptoms of proved cases of pulmonary embolism. This we have done in taking 100 cases of pulmonary embolism from the records of St. Luke's and Research and Educational Hospitals. As Barnes pointed out, it is necessary to avoid the obsession that cyanosis and dyspnea are the cardinal signs of pulmonary embolism.

The variation in the time interval between the first symptoms and death has been discussed repeatedly. We only quote some of the recent statistics. Shambaugh³⁴ reviewed 92 cases of fatal pulmonary embolism which occurred at the Peter Bent Brigham Hospital. Of the 92 patients, 33 were found dead or died shortly after the initial symptoms; 36 survived from ten minutes to one hour; and 15 survived from one to twelve hours. Robertson³⁵ tabulated the clinical signs and symptoms of 146 cases dying of pulmonary embolism and found that 39 per cent gasped, fainted, became pallid, and died within one hour; whereas, 61 per cent had chest pain, cyanosis, and hemoptysis and lived several hours or days. Obviously the latter is the asphyctic, the former the syncopeal type of embolism and the symptoms vary according to the site of the arterial obstruction. Our own figures, to be published elsewhere in detail by Jesser and one of us (de Takats), indicate that if one utilizes the nurses' records for the detection of prodromal signs and symptoms, the interval between the initial symptoms and death is longer than has been reported in other series. Table III summarizes the time

TABLE III
INTERVAL BETWEEN FIRST CLINICAL SYMPTOMS AND DEATH FROM FATAL
PULMONARY EMBOLISM (70 CASES)

TIME ELAPSED BETWEEN FIRST SYMPTOMS AND DEATH	
Found dead or died immediately	3
Ten min. or less	3
From 10 min. to 1 hr.	16
From 1 to 12 hr.	20
From 12 to 24 hr.	4
From 1 to several days	24
Total	70
Died in less than 10 min.	8.5%
Died in less than 1 hr.	31.0%
Died in more than 1 hr.	60.5%

interval which elapsed between the first symptoms and death following pulmonary embolism. It will be remembered that when Trendelenburg first described embolectomy from the pulmonary artery, he stated that approximately 50 per cent died before any kind of help could be administered; in Shambaugh's series about one-third of the patients died sud-

denly or within ten minutes to a day; whereas twenty-four patients, approximately one-third of all cases, lived from one to several days. This latter group, the slowly fatal pulmonary embolus, had either repeated infarcts or showed evidence at post mortem of a progressive thrombosis in the pulmonary artery, not unlike the descending thrombosis one sees following peripheral arterial embolism. Belt³⁶ has especially emphasized that pulmonary embolism is a recurrent event with repeated migration of a blood clot over a period of hours or days.

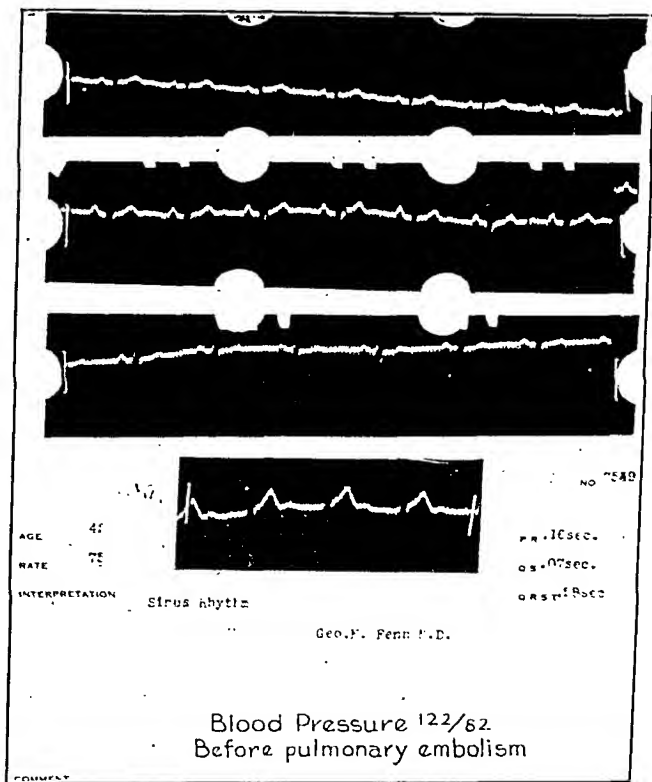


Fig. 7.—Electrocardiogram of G. P., 35-year-old male, previous to a lumbar sympathectomy undertaken for Buerger's disease. It shows a normal tracing.

One can emphatically state then that, provided the nursing and intern staff are made embolism conscious, a large majority of patients, sixty-four out of seventy proved cases in our series, live longer than ten minutes, so there is an opportunity to adopt some therapeutic measures. As Nygaard³³ has pointed out, the possibilities of a successful embolectomy are very slight. The Trendelenburg operation has been carried out up-to-date 132 times with a mortality of 93.2 per cent. It must be pointed out, however, that these embolectomies were all performed on the rapidly fatal cases; the slowly fatal cases, as recently suggested by Pilcher,³⁷ might be operated on two to three hours after the onset of symptoms while not in a moribund state.

The use of drugs to combat pulmonary embolism started with papaverine. Burk,³⁸ Denk,³⁹ de Takats,⁴⁰ and Collins⁴¹ have published reports on patients who were seemingly saved by the intravenous administration of papaverine or "eupaverine," a close derivative of it. These recoveries promptly bring up the question of the percentage of spontaneous recoveries from massive pulmonary infarcts. We have studied the histories of thirteen patients in whom the clinical symptoms, rusty sputum or pure hemoptysis, pleural friction rub, signs of pulmonary consolidation, and x-ray evidence of an infarct made the diagnosis of a

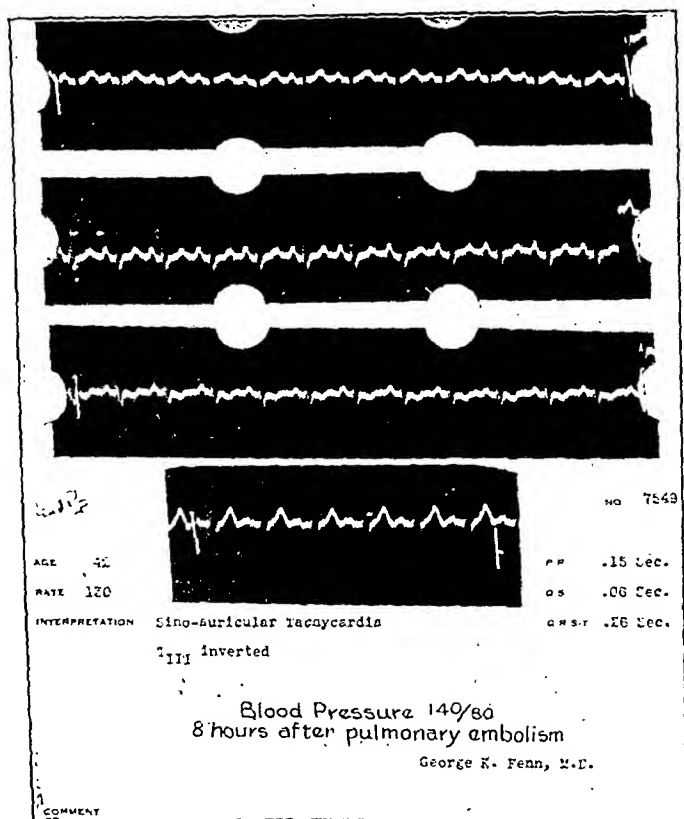


Fig. 8.—Ten days following a lumbar sympathectomy a pulmonary infarct occurred in the right lower lobe. A tracing obtained eight hours after the onset of symptoms revealed an inversion of the T-wave in the third lead. Blood pressure had not fallen but was slightly higher, probably due to pain and anxiety.

nonfatal pulmonary embolism fairly certain. The convalescence of these patients, however, does not resemble the dramatic change in pulse, blood pressure, and color of the patients receiving this medication. In one of our own cases, previously published,⁴⁰ the moribund patient was revived within two minutes after the injection of papaverine. Of Denk's nine cases of severe, massive pulmonary embolism, seven showed a dramatic improvement; in the eighth case both pulmonary arteries were completely plugged and in the ninth an embolectomy was the immediate cause of death. Denk advocated the immediate intravenous injection

of two ampules of "cupaverine," cardiac stimulants, and oxygen. A doctor must sit at the bedside of the patient and keep repeating the drug as soon as the pulse gets worse. In Collins' series, ten patients were treated with "spasmalgin" containing pantopon, gr. $\frac{1}{3}$ (0.21 gm.); papaverine, gr. $\frac{1}{6}$ (0.012 gm.); and "atrinol," gr. $\frac{1}{60}$ (0.001 gm.). Nine out of ten cases recovered. Thus, out of a total of twenty patients treated with papaverine, only three died.

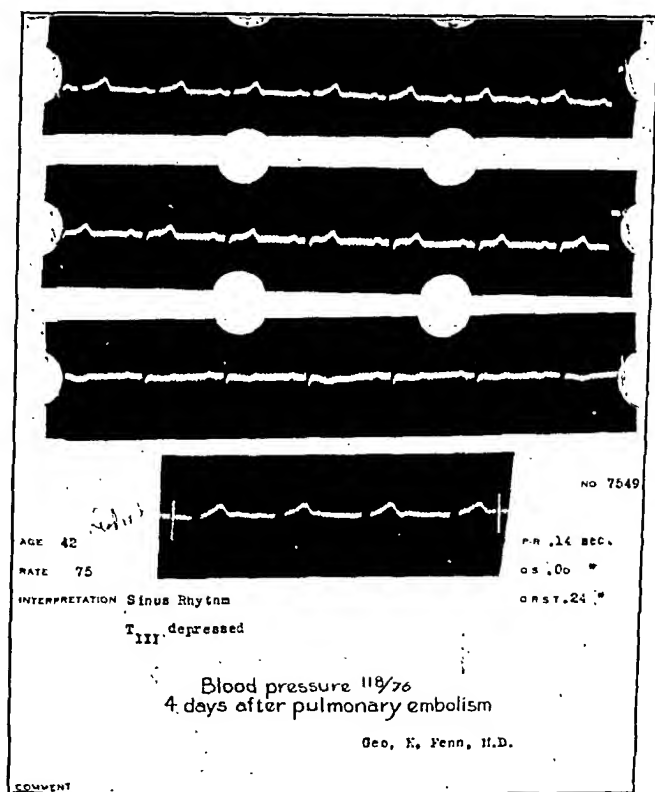


Fig. 9.—Four days after pulmonary embolism T₃ is depressed, but there is some improvement compared with the previous tracing. Blood pressure has returned to the preoperative level.

The use of atropine in pulmonary embolism has been reported by Bardin.² Recent evidence of depressor impulses originating from the pulmonary plexus^{12-14, 16} and the electrocardiographic changes seen in pulmonary embolism,^{9-11, 14} including observations on patients^{12, 13} and our own records on animals, might be interpreted as due to vagal stimulation, although the marked fall in systemic blood pressure, occurring in massive pulmonary embolism, may well be responsible for some of the electrocardiographic changes.

Of the clinical material to be discussed elsewhere in detail, we are presenting three cases which have electrocardiographic tracings and illustrate some of the points under discussion. In the case of G. P., electrocardiograms are available before and eight hours, four days, and

twenty-five days after a pulmonary infarct. The first tracing was taken as a routine record before a lumbar sympathectomy for Buerger's disease. There was no history or clinical evidence of cardiac impairment. It will be noted that following the infarct T_3 first became inverted, later depressed, and then again returned to its upright position. Blood pressure readings taken simultaneously with the tracings prove that, at least in this instance, the electrocardiographic changes are not due to a fall in blood pressure (Figs. 7-10).

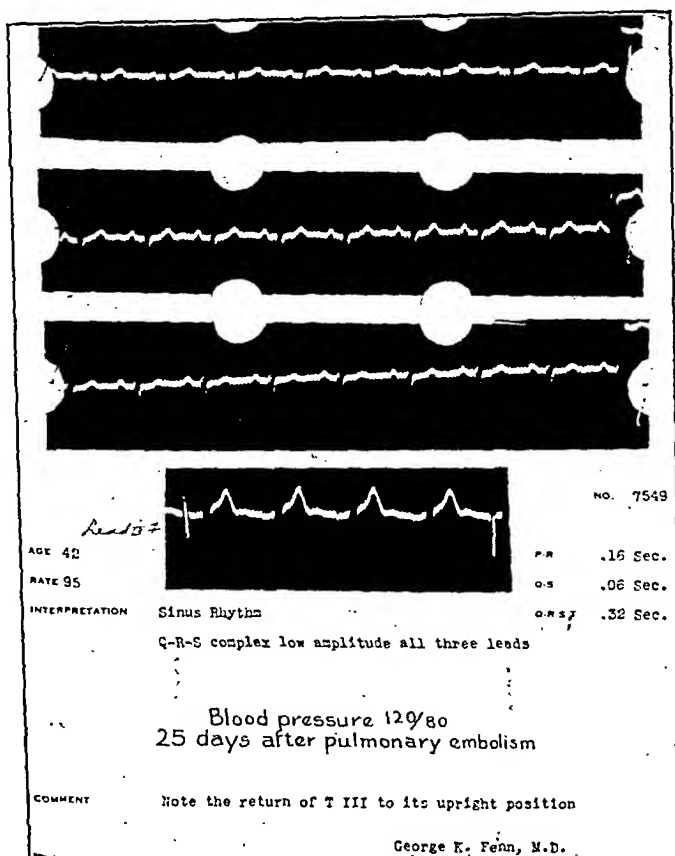


Fig. 10.—Twenty-five days after pulmonary embolism, T_3 returned to its upright position. There is a low amplitude of the QRS complex in all three leads.

In another case of Drs. M. J. Kiley and G. W. Scupham, an electrocardiogram is available twelve hours after a third shower of pulmonary emboli. The blood pressure fell moderately but hardly enough to account for the tracings. While a pre-embolic tracing is not available, an electrocardiogram obtained two and one-half months later shows a disappearance of all the abnormal changes (Figs. 11 and 12).

In a third, fatal case of Drs. H. E. Jones and Arthur A. Elliott, a 65-year-old male patient suddenly collapsed eight days after an appendectomy for a gangrenous appendicitis. Together with dyspnea and cyanosis there was a fall of blood pressure to 30/0, but he recovered

from this attack. The following day, with a blood pressure of 94/72, an electrocardiogram was obtained (Fig. 13). The patient died on the third day following the first syncopal attack. At autopsy multiple obturating emboli of the pulmonary arteries and their small divisions were found, but the main vessel was patent and there was no coronary occlusion.

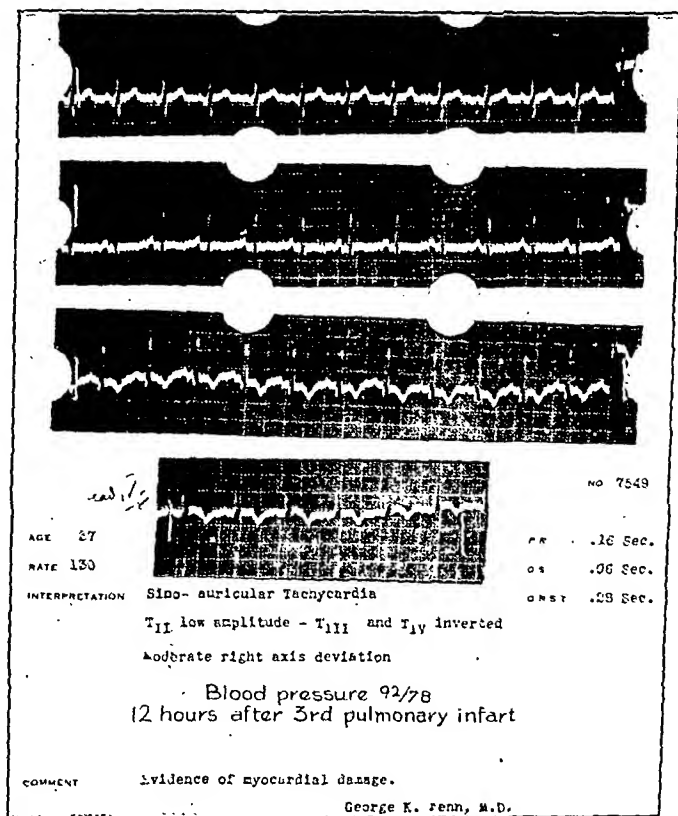


Fig. 11.—This electrocardiogram was obtained twelve hours after a third post-operative pulmonary infarct. Note the low amplitude of T₂, the inversion of T₃ and T₄. There is a moderate right axis deviation. The blood pressure (systolic) fell twenty points.

These three cases illustrate the facts (1) that small or even significant electrocardiographic changes can take place in pulmonary embolism which are reversible; (2) that the fall in blood pressure is not responsible for these changes; (3) that a patient can die of a pulmonary embolus without a massive obstruction; and (4) that the pathologic tracing in the electrocardiogram was not caused by organic coronary occlusion. These changes are either due to right ventricular dilatation and failure, or to reflex vagal effects on the heart, most likely a combination of both.

Whether the electrocardiographic changes are due to vagal coronary constriction or to a reflex vagal depression of the systemic blood pressure,

atropine ought to be useful in inhibiting these reflex changes; while its effect on the vascular tree is negligible, the bronchodilator action may also be of some benefit, thus combating pulmonary edema and atelectasis. A $\frac{1}{150}$ gr. dose of atropine given intravenously is well tolerated; we have given as much as gr. $\frac{1}{60}$ intravenously without any side effect except a transient tachycardia and dryness of the mouth.

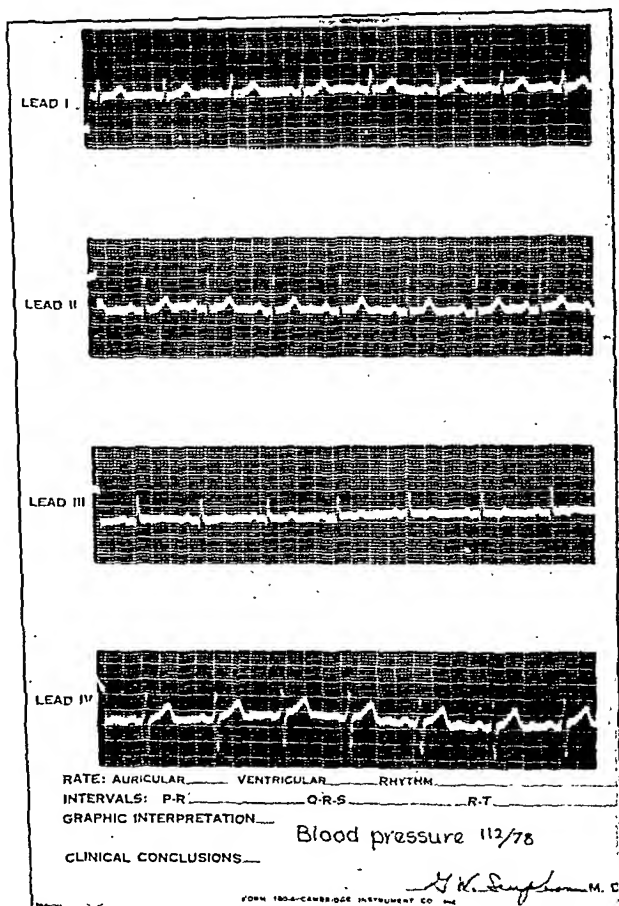


Fig. 12.—Tracing obtained ten weeks later. All the pathologic changes have been reversed.

The use of atropine should not be limited to cases of massive pulmonary embolism which are in extremis but would seem indicated in pulmonary infarcts, where a second or third episode might prove to be fatal. In two recent cases of pulmonary embolism, without cyanosis or shock, the use of atropine, gr. $\frac{1}{150}$, three times a day subcutaneously seemed to improve the dyspnea without, of course, altering the process of consolidation and resolution.*

*Since this article was submitted for publication, experience with the use of atropine and papaverine in the treatment of pulmonary embolism has increased and will be reported in a subsequent publication (Arch. Int. Med.).

The use of oxygen in the form of a tent or by nasal catheter is clearly indicated when dyspnea and cyanosis are present. It was frequently employed in this series and the action on cyanosis and dyspnea often has been marked. In a recently observed case its prompt use greatly relieved the cyanosis; the asphyctic, peripheral type of embolism with no fall in blood pressure but a marked oxygen desaturation, as emphasized by Churchill,⁵ is its real field of usefulness.

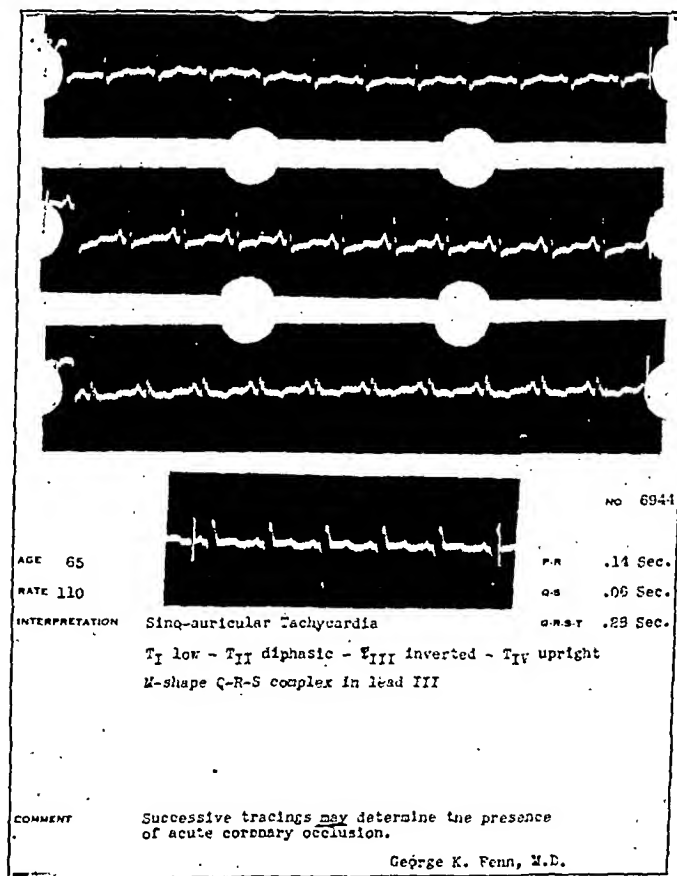


Fig. 13.—Tracing obtained twenty-four hours after a severe, syncopal type of pulmonary embolism. Blood pressure was 94/72. Note that T_I is low, T_{II} diphasic, T_{III} inverted, and T_{IV} upright. There is an M-shaped QRS complex in Lead III. The patient died next day and during his last twenty-four hours two other identical tracings were obtained. At autopsy, multiple peripheral emboli were found, but the main vessel was patent. There was no coronary occlusion and no myocardial lesion.

The use of pressor substances, such as epinephrine, ephedrine, and neosynephrine, is frequently encountered in the histories of patients who exhibit a marked fall in blood pressure. The maintenance of blood pressure is highly desirable to combat cerebral and cardiac ischemia. Epinephrine, however, in our dogs produced such marked pulmonary edema and the rise in pulmonary blood pressure is so definite²⁶ that it

probably did more harm than good. Ephedrine has been especially recommended by the French authors;^{2, 17} its pressor and bronchodilator action may be of benefit. It must be remembered, however, that, as the fall of blood pressure is due to lack of sufficient venous return from the lung to the left heart and an additional reflex vagal action, too much cannot be expected from its use. Neosynephrine, a potent pressor substance, has such a marked stimulating action on the vagus that its use in pulmonary embolism is inadvisable. In a recent study of the use of the drug in spinal anesthesia, Brunner and one of us²⁷ found that electrocardiographic changes, such as partial heart block and shifting of the pacemaker, can be produced temporarily in normal hearts. One should hesitate to add a vagal stimulant to the vagal hypertonus, which seems to exist in cases of pulmonary embolism.

Digitalis and strophanthin, as advocated by some authors¹⁵ to support the failing right heart, are also strong vagal stimulants; they increase the load on the right heart, do not relieve the increased resistance, and decrease coronary flow.⁴⁴

Venesection, advocated in marked filling of the cervical veins in the absence of shock, cannot help if the right heart is completely exhausted; if it is not, it will promptly build up the same intracardiac pressure as before. The release of some of the peripheral resistance in the pulmonary bed should be the goal of any medical treatment; this is best accomplished by papaverine; whereas, the nitrites, because of their depressant action on systemic blood pressure, are certainly contraindicated.

Recently, the infiltration of the stellate ganglion with procaine has been advocated by Leriche and his co-workers.⁴⁵ They studied the post-mortem material of the Institute of Pathology at Strasbourg and found that of 225 cases of pulmonary embolism the main trunk or both main branches were obstructed in 159 cases, roughly 70 per cent. That left 30 per cent of the patients who died even though only one branch or one or several lobar arteries were blocked. In this type, the abolition of sympathetic pulmonary vasoconstriction may be life saving in their opinion. Out of three of their personal cases, one was successful but two failed. They advocated having suitable needles on hand in every large ward and infiltrating on the side of the chest pain or bilaterally.

The technique of stellar infiltration is not difficult. We have used it repeatedly in our clinic for a preoperative test before a contemplated sympathectomy. It no doubt releases the sympathetic vasoconstriction of the pulmonary vascular bed, which, according to de Burgh Daly's⁷ studies, is quite active. While it is not as simple to carry out as an intravenous injection of papaverine, the suggestion deserves further trial. If it decreases pulmonary hypertension by decreasing the resistance in the pulmonary vascular bed, it may well fit in with our other therapeutic attempts to transform a complete occlusion into a partial one.

DISCUSSION

It is obvious from the start that the massive pulmonary embolus, which plugs the main trunk or both main branches completely, kills instantly or within a few minutes. It is not likely that an embolectomy could be performed soon enough to save such a patient's life. In the statistics quoted by Leriche,⁴⁵ 30 per cent of the patients, however, die with the findings of only a comparatively small, partial occlusion. Such cases have been reported several times. As early as 1924, Sauerbruch reported the case of a 32-year-old woman who died from a pulmonary embolism following a hernia operation; an embolus 3 mm. in diameter was found in a small branch of the pulmonary artery, 4 cm. from the periphery of the lung. The major arteries were patent. In our autopsy material a typical death from pulmonary embolism occurred in the presence of minor pulmonary obstruction in seven out of thirty-five cases. Pathologists at present are rather loath to accept such a finding as a cause of death and probably many more such cases will be found in the future.

But if death can occur reflexly from the occlusion of one or two lobar branches, why do patients tolerate a lobectomy or a pneumonectomy without any serious disturbance of circulation? Among others, O'Shaughnessy⁴⁶ has studied the reflexes originating from the root of the lung and found respiratory and cardiovascular reflexes originating from the pulmonary plexus which could be abolished by local application of cocaine. Sunder-Plassmann⁴⁷ found powerful myelinated nervous receptors in the submucosal bronchial musculature and could obtain cardiac standstill on intrabronchial pressure. He advised topical application of novocain, even during general anesthesia. Cullen and Ravenstone⁴⁸ reported three instances in which the patients suddenly died when the hilus of the lung was ligated or cut with the electric cautery. That these events do not occur more frequently is probably due to the depth of anesthesia and the premedication which effectively suppresses such reflexes in the animal experiment. In our own work it was early found that when the animals were under ether anesthesia or under heavy barbiturates the usually fatal dose would not kill them; for this reason only morphine was used as a premedication in all our later work; this drug does not depress vagal reflexes but instead facilitates them.

If one places the pulmonary hypertension proximal to the obstructing clot, as the essential functional lesion contributing to death and responsible for the electrocardiographic changes, then all therapeutic attempts must be focused to relieve this hypertension or to abolish the reflex impulses emanating from it. Papaverine and the infiltration of the stellate ganglion both release the vascular spasm of the arterial tree. This collateral vascular spasm has been repeatedly and unequivocally demonstrated in the peripheral arteries when an embolus plugs the main

arterial pathway.⁴⁹ Its demonstration in the pulmonary circulation is difficult, but the work of Daly and his collaborators has adequately shown the potent sympathetic vasoconstriction which operates in the pulmonary vascular tree.

The cause of collapse and the fall in blood pressure usually has been explained by the inadequate transfer of blood from the right heart to the

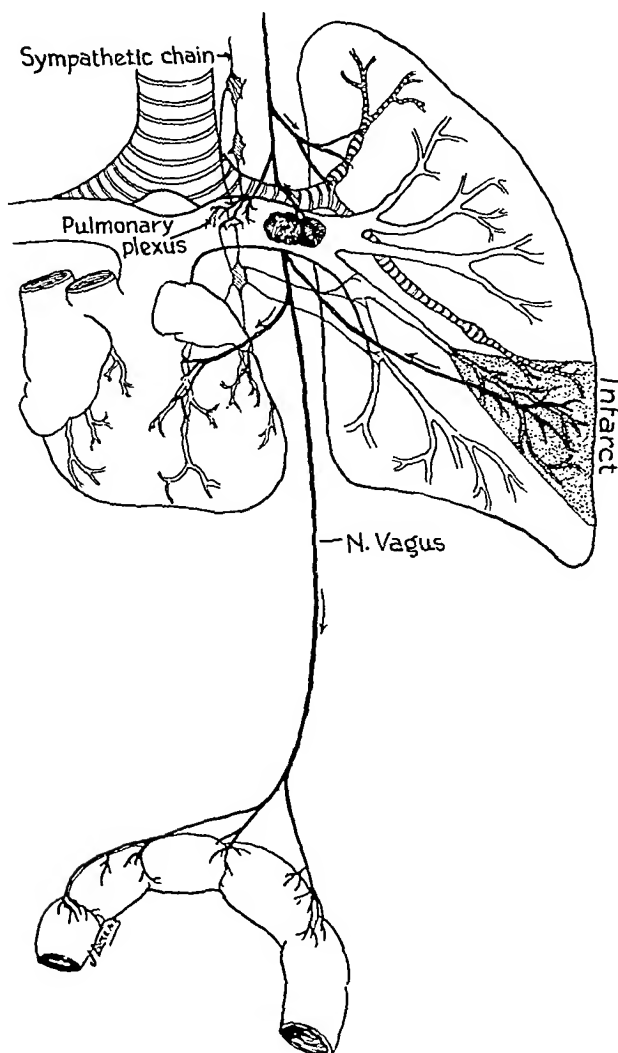


Fig. 14.—The radiation of autonomic reflexes from the occlusion of the pulmonary vascular bed, bronchi, and pleura. The afferent impulses travel mainly in the vagus and radiate back to the lung as bronchoconstrictor and bronchosecretory fibers. They may constrict the coronaries, produce vagal inhibition of the heart, and depress blood pressure. They can radiate to the upper gastrointestinal tract and produce colics, increased and reversed peristalsis. The plug may produce a stimulation of the sympathetic vasoconstrictors or a more general sympathetic stimulation through the dilatation of the right heart (Bainbridge reflex). The hypertension in the right heart and in the pulmonary artery seems to be the main stimulus for these widespread reflexes, although the rise in intrapulmonary pressure, the congested lung, and the irritated pleura all have been shown to act as reflexogenic factors.

left so that effective blood volume is markedly diminished.⁵ But we have quoted good evidence for highly sensitized vasoreceptors in and around the pulmonary artery,^{12, 13} in the bronchi,⁴⁷ and in the pleura,⁵⁰ the stimulation of which produces widespread reflex changes, such as fall in blood pressure, vagal inhibition of the heart, coronary constriction, bronchial spasm, and increased gastrointestinal motility (Fig. 14). Some of these reflexes seem to travel through the vagus; their abolition or diminution with atropine seems logical. Thus, while atropine does not affect the pulmonary hypertension, it inhibits a depressor reflex originating from it. This reflex may become a major contributory cause of death.

Oxygen administration seems highly desirable when cyanosis is present or when respiration is labored. There is no need to belabor this point.

Based on this experience, we feel that every surgical floor should be equipped with gr. $\frac{1}{150}$ of atropine tablets and gr. $\frac{1}{2}$ powders of papaverine, both of which can be rapidly boiled in a spoon with a few cubic centimeters of water and injected intravenously; that oxygen tanks should be readily available when a pulmonary infarct has occurred; that the use of digitalis, strophanthin, and neosynephrine in the syncopal type of pulmonary embolism may do more harm than good.

Finally we wish to emphasize again that a large percentage of patients dying from pulmonary embolism will continue to die, in spite of all these measures, when the clot completely obstructs the main artery. Only measures to prevent thrombosis or to prevent the existing thrombosis from breaking loose will diminish the incidence of such fatalities. We wish to draw attention, however, to certain neurocirculatory changes which may turn a nonfatal into a fatal embolus. When surgeons, interns, and nurses are made conscious of certain measures outlined above, this dreaded fatality may be averted in certain favorable cases.

SUMMARY

1. Experimentally, two types of fatal pulmonary embolism have been produced: one which plugs the terminal vascular bed and is characterized by cyanosis and dyspnea; and the other which represents an obstruction to the main pulmonary artery and exhibits a syncopal attack with pallor and fall in blood pressure.

2. The possible mechanisms of death have been analyzed. Atropine protects a large percentage of animals dying from the massive type of embolism, and so does papaverine. Oxygen is helpful in the peripheral type of embolism.

3. Electrocardiograms taken in dogs before and after the production of a massive pulmonary embolism present a picture resembling a serious interference with coronary flow. The possible causes of these findings are analyzed.

4. The clinical application of these findings is discussed. In our series of 100 cases of pulmonary embolism, 87 died and 13 survived. Of the fatal cases, less than 10 per cent died within the first ten minutes, thus allowing time for emergency measures.

5. On the basis of the experimental findings, a combination of atropine and papaverine is advocated to counteract the radiation of autonomic reflexes, which originate in the affected lung. Oxygen is obviously useful in the peripheral type of embolism, in which vasomotor collapse is absent but cyanosis predominates.

6. A few other drugs commonly employed, such as epinephrine, neosynephrine, digitalis, and strophanthin, are discussed but not recommended.

7. As manifest thrombosis of the veins of the pelvis and lower extremities is comparatively rarely encountered in patients with massive pulmonary embolism and heparinization of a large number of post-operative cases is yet impossible, the early and active interference with the described autonomic reflexes occasionally may be the only available life-saving measure.

It is a pleasure to thank Dr. George E. Wakerlin, head of the Department of Physiology, University of Illinois, College of Medicine, for his valuable suggestions and for the use of some of the facilities of his department.

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OVARIAN TUMORS AND UTERINE BLEEDING

I. GRANULOSA CELL TUMORS

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ABNORMAL uterine bleeding may be associated with ovarian tumors. Its diagnostic value in cases of granulosa cell tumor recently has been emphasized. However, the solid granulosa cell tumors comprise only a small group of ovarian neoplasms, 6 out of 100 consecutive cases in Lynch's series, and abnormal menstruation may be associated with other pathologic types. The present study, therefore, was undertaken to determine the relative incidence of uterine bleeding in all varieties of ovarian tumors. The records of 376 ovarian tumors on file in the Surgical Pathological Laboratory of the Johns Hopkins Hospital and the gynecological service of the Church Home and Infirmary were analyzed to determine the types of ovarian neoplasms associated with abnormal bleeding and the pathologic changes responsible for the bleeding. In this study it was found that menstrual irregularities were practically restricted to specific pathologic types of ovarian tumors, but that a variety of mechanisms accounted for the uterine bleeding. The largest group of cases comprises forms of granulosa cell tumor in which the endocrine activity of the tumor (estrogen secretion) results in endometrial hyperplasia and functional bleeding. The second largest group are pseudomucinous cystadenomas (benign and malignant) in which uterine bleeding also may result from endometrial hyperplasia, but in which the underlying endocrine factors are more varied and less accurately understood. The third group comprises papillary cystadenocarcinoma of Müllerian derivation in which abnormal uterine bleeding is the result of tubal or endometrial carcinoma, either metastatic or possibly multicentric in origin. In a fourth group of cases, ovarian neoplasms of teratomatous nature are associated with menstrual disturbances resulting from the endocrine activity of the tumor tissue.

In the present communication the largest group of tumors associated with abnormal uterine bleeding is considered. This comprises the granulosa cell group. A series of 59 typical granulosa cell tumors from the Surgical Pathological Laboratory is reported and in addition a more malignant and papillary form of granulosa cell tumor is described. This form hitherto has not been included and has been loosely grouped as papillary cystadenocarcinoma. Because of the large number of contribu-

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tions to the subject of granulosa cell tumor in the recent literature, the data on the present series of 59 granulosa tumors are briefly summarized and more detailed consideration is given to the papillary granulosa cell carcinoma.

PAPILLARY GRANULOSA CARCINOMA

Among the papillary ovarian carcinomas in the Surgical Pathological Laboratory of the Johns Hopkins Hospital and the Church Home and Infirmary, there are 35 tumors which we believe should be included among the granulosa cell group because of both their morphologic and physiologic properties. This form of ovarian tumor appears in postmenopausal and menopausal women, is frequently associated with abnormal uterine bleeding, and runs a rapidly malignant course; in many cases it has already metastasized when the patient first presents herself for examination. Grossly, the tumor is usually cystic, having sessile papillary projections with a tendency to peritoneal implantations.

This neoplasm has been described and illustrated by Shaw, who groups it with the papillary serous cystadenocarcinomas; and by Varangot, who refers to it as "*le végétant épithélioma papillaire atypique*." It has been variously referred to in the literature as medullary carcinoma, solid papillary carcinoma, adenocarcinoma and carcinoma in ovarian cyst, but it has never been systematically included in the classification of ovarian tumors.

Approximately 40 per cent of all ovarian carcinomas belong to this group. They can be distinguished from the so-called papillary serous cystadenocarcinoma, or, as we prefer to call it, the Müllerian carcinoma, microscopically, physiologically, and clinically.

Clinical Features.—The tumor characteristically occurs in women who have passed the menopause; 19 out of 27 (72 per cent) cases in which the age is available are postmenopausal. The complaint is usually a gradual increase in the size of the abdomen in association with slight pain. It is significant that 10 out of 22 cases in which menstrual histories were available complained of some form of abnormal uterine bleeding (Table I). A pelvic examination reveals the presence of an irregular or cystic mass in the adnexal region, the malignancy of which may be suspected by the presence of palpable nodules over the surface of the cyst or on the peritoneal coverings in the cul-de-sac. Eleven, or 50 per cent, of our cases in which the location of the tumor is given were either bilateral at the time of operation or later had recurrence in the unaffected ovary. At operation a small amount of bloody ascites may be present and there are frequently peritoneal and omental metastases. The metastases, however, are usually flattened plaques and under the peritoneal serosa rather than the cauliflower, friable transplants of the Müllerian type of papillary tumor (papillary cystadenocarcinoma). Metastases to distant organs and regional lymph nodes occur less commonly.

TABLE I
SUMMARY OF CASE HISTORIES OF PAPILLARY GRANULOSA CARCINOMA

PATIL. NO.	AGE	MENSES	INVOLVEMENT	HYPERESTRINISM	THERAPY	RESULTS
18048	46	Regular	Right ovarian cyst, bloody ascites	Tubal hyperplasia	Right salpingo-oophorectomy, x-ray	Died 1 yr., recurrence
18066	49	18 mo. amenorrhea; 6 wk. bleeding	Right ovarian cyst, bloody ascites	-	Right salpingo-oophorectomy, x-ray	Well 1 yr.
10777	44	-	Bilateral ovarian tumors with peritoneal transplants and ascites	Tubal hyperplasia	Bilateral salpingo-oophorectomy	Died 5 mo.
10569	45	Menses 6 days overdue	Bilateral ovarian tumors, peritoneal transplants	-	Hysterectomy, bilateral salpingo-oophorectomy	Died 1½ yr.
9834	53	Menopause 5 yr.; no post-menopausal bleeding	Right ovarian tumor, peritoneal transplants	-	Right salpingo-oophorectomy	-
5885	-	-	-	Tubal hyperplasia	-	-
5711	57	Menopause 7 yr.; no post-menopausal bleeding	Right ovarian tumor	-	Right salpingo-oophorectomy	Died 1 yr., recurrence
5063	-	-	Ovarian cyst	-	-	-
4655	55	Menopause 2 yr.; no post-menopausal bleeding	Bilateral ovarian cysts	Tubal hyperplasia	Bilateral salpingo-oophorectomy	Died 7 mo., recurrence
3792	58	Menopause at 38 yr. of age; bloody spotting, 3 wk.	Pelvic mass	-	-	-
2247	50	Menopause at 41 yr. of age; vaginal bleeding, 2 days 3 mo. ago	Bilateral ovarian tumors, peritoneal metastasis	-	Bilateral salpingo-oophorectomy	-

1590	59	Menopause 7 yr.; vaginal bleeding, 1 yr.	Bilateral ovarian cysts, peritoneal metastasis	Endometrial hyperplasia	Panlysterectomy with bilateral salpingo-oophorectomy	-
12289	53	-	-	-	-	Death 1 yr.
17728	50	Menopause at 44 yr. of age	Left ovarian tumor, ascites	-	-	-
18143	-	-	-	-	-	-
20274	58	Menopause at 55 yr. of age	Right ovarian tumor	Hyperplasia of tube	Right salpingo-oophorectomy	Died
20300	-	-	-	-	-	-
28919	56	-	Bilateral ovarian tumors, peritoneal metastasis	-	Bilateral salpingo-oophorectomy	Died postoperatively
30942	45	Flooding 2½ yr.	Bilateral ovarian tumors	Endometrial hyperplasia	Hysterectomy, bilateral salpingo-oophorectomy	Alive 8 yr.
34424	-	-	-	-	-	-
40210	49	Regular until operation 5 mo. ago	Bilateral ovarian masses	-	Left salpingo-oophorectomy; right ovary previously removed	Died 5 mo., recurrence
46926	40	Regular	-	-	-	Died 11 mo.
48816	40	Regular	-	-	-	-
49512	36	-	-	-	-	-
54604	68	Menopause 20 yr. ago	Generalized abdominal metastasis	-	-	Died 6 wk.
55424	64	Menopause at 52 yr. of age; 2 mo. bleeding	Right ovarian cyst	Endometrial hyperplasia	-	-

TABLE I—CONT'D

PATIL. NO.	AGE	MENSTRUUS	INVOLVEMENT	HYPERESTRINISM	THERAPY	RESULT
57458	50	Menopause at 48 yr. of age	Right multilocular ovarian cyst, peritoneal metastasis	-	Hysterectomy, right salpingo-oophorectomy	Died postoperatively
57466	50	Menopause at 49 yr. of age; spotting 10 days	Right ovarian cyst	-	Right salpingo-oophorectomy	Death 13 mo., recurrence and metastasis
57562	50	Menopause at 48 yr. of age; no postmenopausal bleeding	Ovarian cyst with lymphatic, peritoneal, and omental involvement	-	Removal of tumor	Death 8 mo.
57526	30	Menorrhagia and dysmenorrhea 1 yr.	Right ovarian cyst, bloody ascites	-	-	-
57740	67	Menopause 12 yr. ago; no postmenopausal bleeding	Right ovarian cyst	-	-	-
57742	42	Regular	-	-	-	-
58288	61	No postmenopausal bleeding	-	-	Right salpingo-oophorectomy; x-ray	Death 27 mo.
58434	-	-	Widespread abdominal metastasis	-	-	-
59144	52	Menopause at 50 yr. of age; spotting on three occasions	Right ovarian cyst	-	-	-

Pathology.—Grossly the tumor is polycystic with papillary portions. These papillary areas, however, are usually flattened and resemble mulberries rather than the grapelike projections of the Müllerian tumor. The cysts, which are usually unilocular, reach an average size of 12 cm.



Fig. 1.—Path. No. 30942. Gross specimen of papillary granulosa cell carcinoma, showing cyst filled with finely papillary growth.



Fig. 2.—Path. No. 28910. Papillary type of granulosa cell carcinoma showing cyst lined with many layers of granulosa like cells and typical cross section of a papillary projection.

in diameter but may attain even larger dimensions. The largest tumor in the present series measured 21 by 8 by 5 cm. The content of the cysts differs greatly, grading from a bloody, viscid, gelatinous material to a thin, serous, yellow fluid. The appearance of such cysts in granu-



Fig. 3.—Path. No. 40210. Epidermoid border of a cyst in a papillary granulosa cell carcinoma, showing thecalike reaction of underlying stroma.

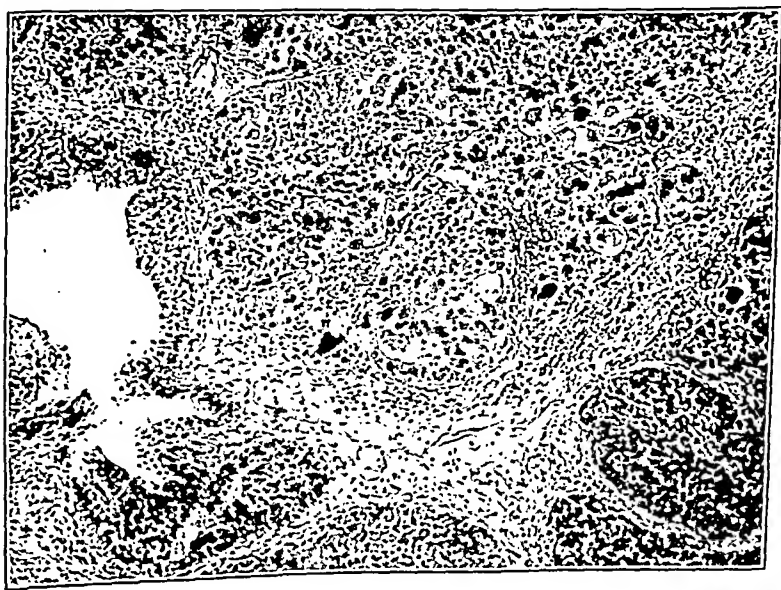


Fig. 4.—Path. No. 58288. Illustrating the variation in size of cells in certain areas of a papillary granulosa cell carcinoma.

losa cell tumors is not unusual; indeed, it is not uncommon for them to reach 8 or 10 cm. in diameter as mentioned below under the gross description of the micro- and macrofollicular types of granulosa cell tumor. The solid tumor tissue is usually yellow in color and of brainlike consistency. Its cut surface is cellular and can be teased apart to show a fine, papillary structure (Fig. 1). These solid portions may completely occlude the cyst. Two cases of the present series were described as solid tumors.

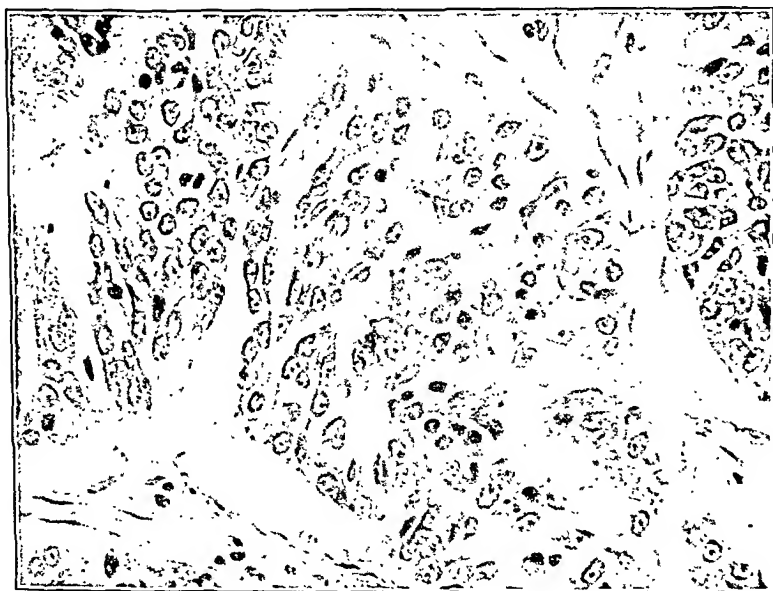


Fig. 5.—Path. No. 18066. A perpendicular arrangement of cells bordering a cyst seen occasionally in the papillary granulosa cell carcinoma.

Microscopically the tumor is characterized by broad, flat layers of epidermoid cells from three to twenty-five rows deep, lining cysts in a pseudopapillary arrangement (Fig. 2). Occasionally there are cysts lined by a single row of atypical cuboidal cells. A cross section of the papillary projections shows a centrally placed blood vessel surrounded by the typical band of epidermoid cells (Fig. 2). Some of the epidermoid borders have well-defined basement membranes, while others merge into the underlying stroma (Fig. 3). In some areas the abundant stroma is invaded by solid islands of the epidermoid cells. Mitotic figures are frequent and there is a great variation in the staining and size of the cells, which in places attain diameters of 15 mm. (Fig. 4). Still other areas present cysts which appear to be lined by perpendicular columns of the same epithelial cells. There are spaces between these columns which resemble superficially Call-Exner bodies (Fig. 5).

Follow-Up Reports.—The tumor is extremely malignant as the operative findings frequently indicate. Of 18 followed cases, 15 were

dead in less than three years postoperatively. Two are still living less than two years postoperatively and only 1 is living over five years. In this case small bilateral ovarian tumors were found unexpectedly during an operation performed for uterine bleeding. A bilateral salpingo-oophorectomy and hysterectomy were performed.

Treatment.—Because the tumors exhibit a marked tendency to occur bilaterally, bilateral salpingo-oophorectomy and hysterectomy were the operations of choice. A hysterectomy is advised if the condition of the patient permits, first, because the uterus is a useless organ after a bilateral salpingo-oophorectomy has been performed; and second, because of the possibility of its involvement in the malignant process. In cases associated with uterine bleeding, either the uterus should be removed at operation or a dilatation and curettage should be performed preoperatively to eliminate the possibility of secondary transplants or concomitant tumors in the uterus.

A study of 9 cases in which a unilateral salpingo-oophorectomy was performed, showed 4 cases with proved recurrences in the remaining ovary from three to eighteen months postoperatively. As most of the patients are approaching or have already passed the menopause, 19 out of 27 cases, the interference with biologic function is usually not an important consideration. This is in sharp contrast to the more benign forms of granulosa cell tumors which occurred during active sexual life in 62 per cent of the cases (Table III). In 231 cases of solid granulosa cell tumors collected from the literature by Varangot, 134 cases occurred in women during active sexual life in contrast to 97 at or near the menopause. An attempt should be made to establish the pathologic diagnosis at the time of operation and in doubtful cases a frozen section should be obtained.

Irradiation therapy was limited to 4 cases, 1 of which was treated elsewhere and the details of treatment are unknown. However, in this case the tumor was incompletely removed as implants were already present at the time of operation. A bilateral salpingo-oophorectomy and hysterectomy were performed and deep x-ray therapy was administered postoperatively. The patient died one and one-half years postoperatively. The results obtained in the other three cases were also poor (Table II). Two completely operable cases were given prophylactic postoperative irradiation. One is dead from a massive recurrence and the other, although still alive one and one-half years postoperatively, has a mass in the opposite ovary which is probably a recurrent carcinoma. A case in which the tumor was incompletely removed at operation was relieved of ascites for a short while, but there was never a noticeable decrease in the size of the abdominal mass.

Pathologic Physiology and Histogenesis.—The clinical histories of the reported cases give certain clues as to their histogenesis as has previously been suggested. Ten out of 22 cases, or 45 per cent, complained of either

TABLE II

TABLE OF IRRADIATION THERAPY IN PAPILLARY GRANULOSA CARCINOMA

CASE NO.	OPERABILITY	OPERATION	X-RAY THERAPY	RADIUM THERAPY	RESULTS
18068	Operable	Right salpingo-oophorectomy 1/26/37 Exploratory 1/24/38	Prophylactic 3/1-8/37, 9,500 r.*; 10/2-12/3, 2,000 r.	12/30/37- 1/14/38 Total, 16.6 gm. hr.†	Recurrence 5/22/37 Death 1/24/38 with massive recurrence
18066	Operable	Right salpingo-oophorectomy 1/26/37	Prophylactic 2/16-27/37, 8,000 r.*; 4/5/37 1,000 r.	None	8/20/38 cystic mass in left adnexal area, probably re- currence
10596	Partially operable	Bilateral salpingo-oophorectomy and hysterectomy 1/30/30	4/11-14/30, 2,500 r.‡	8 gm. hr., 1/27/31§ 4/11-13/31, 10 gm. hr.¶	2/27/31 mass unchanged, no ascites; 4/11/31 recur- rent ascites; 8/31/31 death

*Factors: Filter, 1 mm. Cu, 1 mm. Al, 30 Ma., 210 KVP, 50 F.S.D., time 4 min., 8 portals 10/10 cm.

†Factors: Emanations used, 4 abdominal portals, time 1 hr., 2,667 to 4,110 mc., filter 2 inch platinum at 2 inch distance.

‡Factors: Filter 1 mm. Cu, 1 mm. Al, 30 Ma., 200 KVP, 50 F.S.D., time 20 min., 5 portals 20/20 cm.

§Factors: Emanations used, 4 abdominal portals, time 30 min., 2,890 to 3,638 mc., plain pack at 2 inch distance.

¶Factors: Emanations used, 2 abdominal portals, time 1 hr., 3,228 to 3,506 mc., 2 inch cylinder at 3 inch distance.

profuse menstruation or postmenopausal bleeding. Although this cannot be accepted as absolute evidence of hyperestrinism, it is certainly suggestive when other lesions have been excluded as a cause of bleeding. In a series of 59 solid granulosa cell tumors tabulated below, 62 per cent complained of abnormal menses. In contrast to these findings, not a single case in a series of papillary ovarian carcinoma of Müllerian type was associated with abnormal uterine bleeding unless there was an associated uterine or tubal growth.

Endometrium was available in only three cases and in all it was hyperplastic. A study of the tubal epithelium in five cases showed definite hyperplasia in four and active epithelium in one postmenopausal case. Such histologic findings are comparable to those found in a study of uterine and tubal mucosa in a series of cases in which a typical granulosa cell tumor was present. It therefore seems that patients with papillary carcinoma of the above-described type are bleeding because of the effects of endocrine stimulation on the endometrium. Since this is also the cause of bleeding in patients with typical granulosa cell tumors, the histologic findings may be used as presumptive evidence that the papillary ovarian carcinoma under discussion belongs to the granulosa cell group.

Morphologically the cells of the papillary carcinoma described are similar to those of the diffuse and microfollicular forms of granulosa tumor and bear a greater resemblance to the true granulosa cells than

TABLE III
SUMMARY OF CASE HISTORIES OF SOLID GRANULOSA CELL TUMORS

CHARACTER	PATH. NO.	AGE	MENSES	INVOLVEMENT	TREATMENT	RESULT
Diffuse with dermoid cyst	57720	39	9 mo. amenorrhea	Right ovarian cyst	Right salpingo-oophorectomy	Living 9 mo. postoperatively
Diffuse	16213	13	Irregular	Left ovary; ascites	Left salpingo-oophorectomy	Living 16 yr.
	21701		Irregular; hyperplasia	-----	Bilateral salpingo-oophorectomy, hysterectomy	Dead ?
	28216	56	Operative menopause	Left ovary	Left salpingo-oophorectomy	-----
	29820	49	Irregular; hyperplasia	Ascites	X-ray, hysterectomy, bilateral salpingo-oophorectomy	-----
	37276	64	-----	Operations 1922 and 1925	-----	Well 3 yr.
	40452	13	Normal	-----	-----	Well 8 yr.
	49712	47	Hysterectomy	Bilateral with peritoneal metastasis	Bilateral salpingo-oophorectomy	Well 2 yr.
	53984	25	-----	-----	-----	Died at 30 days with widespread metastasis
	55358	59	Postmenopausal bleeding	Omental metastasis	Laparotomy	-----
	57464	32	-----	Left ovarian tumor	-----	Died with lung metastasis and local recurrence
	57532	73	-----	-----	-----	-----
	57554	48	Irregular	Unilateral	Oophorectomy	Living 4 yr.
	57560	54	No postmenopausal bleeding	-----	-----	-----

		Amenorrhea 2 mo.; negative Friedman test	-----	Ascites	Living 2 mo.
57636	16				
57866	51		Left cyst	Hysterectomy, left sal- pingo-oophorectomy	-----
57980	53		Liver and intestines	-----	-----
59096	54		Left ovary	-----	-----
36790	64	Leucorrhea		Hysterectomy, bilateral salpingo-oophorec- tomy	Died 11 yr. postoper- atively
52214	42	Regular		-----	Living, 2 mo.
52498	56	Vaginal bleeding	Solid ovarian tumor re- moved 1½ yr. pre- viously	Laparotomy?	Died 1 yr.
53986	25			-----	Well 18 mo.
54150	62	No postmenopausal bleeding		-----	Died postoperatively
56236	65	No postmenopausal bleeding		-----	-----
57372	22	Amenorrhea 2 mo.; negative Friedman test	Right ovarian tumor	Operation, x-ray	Died 2½ yr., metastasis to liver and lungs
57884	45	Regular		-----	-----
58302	--			-----	-----
58580	21	Amenorrhea 2 mo.		-----	3 mo. axillary nodes
59142	33	Prolonged and profuse	Left side	Hysterectomy, bilateral salpingo-oophorec- tomy	-----
61055	--			-----	-----
C.H.L. 19076	31	Irregular 1 yr.; amen- orrhea 3 yr.	Right ovarian cyst; myoma	Right salpingo-oopho- rectomy; myomec- tomy	Living and well 9 mo. postoperatively

Sarcomatous

TABLE III—CONT'D

CHARACTER	PATH. NO.	AGE	MENSES	INVOLVEMENT	TREATMENT	RESULT
Microfollicular	35234	31	-----	One side removed and recurred in operation 2 mo. later	-----	-----
	30966	59	Brownish discharge; hyperthyroidism	-----	-----	-----
	51196	44	Regular; amenorrhea 2 yr.	Left ovarian cyst	-----	-----
	57442	53	Irregular 6 mo.; hyperplasia	Unilateral	-----	Died postoperatively
	57744	42	Amenorrhea 8 mo. with occasional spotting; positive Friedman test	Left ovarian cyst; peritoneal metastasis	Hysterectomy, bilateral salpingo-oophorectomy	-----
	57990	--	-----	-----	Operation, x-ray treatment	Died 15 mo. postoperatively
	58260	26	Irregular; endometrial hyperplasia	-----	-----	-----
	58836	43	Irregular; hyperplasia	Unilateral	-----	-----
	59132	43	-----	Left intraligamentary cyst	Hysterectomy, unilateral salpingo-oophorectomy	-----
(Church Home and Infirmary)		48	10 mo. amenorrhea; 8 mo. bleeding; hyperplasia	Left ovarian cyst	Hysterectomy, left salpingo-oophorectomy	Living and well 7 yr. postoperatively
	-----	22	Always irregular and profuse	-----	Bilateral salpingo-oophorectomy panhysterectomy	Living 18 yr. postoperatively
Cylindroid	4948	--	-----	-----	-----	-----
	13364	3	-----	Bilateral	-----	Died 6 mo.; widespread metastasis

some of the other subdivisions of the *granulosa class*. Certain areas of the papillary tumors under discussion show more variations in nuclear size and staining characteristics and a greater number of mitotic figures than previously described for the forms of granulosa cell tumors. However, this is in keeping with their more malignant character. The tumor is therefore to be regarded histologically as the most malignant type of granulosa cell tumor and the source itself of the estrin responsible for the endometrial hyperplasia.

SOLID GRANULOSA CELL TUMORS

All of the recognized types of solid granulosa cell tumors have been briefly reviewed and clinical data on 59 cases recorded in the Surgical Pathological Laboratory have been tabulated.

Granulosa cell tumors have been much discussed during the past decade and it is well recognized that clinically the cases present a hyper-estrin syndrome consisting of abnormal uterine bleeding and engorged painful breasts. The menstrual irregularities are typically those produced by endometrial hyperplasia, that is, intervals of amenorrhea of two to six months' duration succeeded by long periods of menorrhagia; dysmenorrhea is never present. This syndrome is so striking when it appears after the climacteric that these cases have been over-emphasized and the impression is frequently gained that granulosa cell tumors occur more commonly in postmenopausal women. Such an impression is erroneous since 28, or 61 per cent, of the cases in the present series occurred before the age of 50 years. Seventy-five per cent of the cases collected by Varangot occurred during active menstrual life. (Table III.)

Sixty-two per cent of the cases complained of abnormal uterine bleeding. Endometrium was available in only 7 cases in the present series and in every instance endometrial hyperplasia was found. There were 2 cases with myomata uteri.

The malignancy of granulosa cell tumors is given by Varangot as 25 per cent, excluding postoperative deaths. Of 146 cases collected from the literature, 20 died postoperatively, 32 had metastasis and recurrences, 63 were living and well under five years, and 28 were living and well over five years. In the series reported by Novak and Brawner, 28 per cent of the cases were malignant. In our series of 32 followed cases, 15 are dead, 11 are living and well under five years, and 7 are well over five years. In all, 46 per cent were malignant. Because of the tendency to late recurrence and metastasis, the prognosis should be guarded. In one case in the present series a recurrence took place sixteen years following the original operation (Case, Path. No. 24407, reported by Compton¹).

The radiosensitivity of the granulosa cell tumor is difficult to evaluate because of the paucity of records available and because of the relatively

benign course in some cases. Two patients in the present series treated by x-ray died within three years. In one case (Path. No. 57744) no data as to the amount of therapy given were available. In the second case (Path. No. 57572) the patient received 1,856 roentgen units to each of four portals, 10 by 10, two anterior and two posterior, over a period of three weeks. The factors used were 30 Ma., 210 KVP, at 50 S.T.D. with 1 mm. Cu 1 mm. Al filter for ten minutes. The patient had had peritoneal transplants at operation and therefore should be classified as a partially operable case. She responded well for one and one-half years. A recurrent pelvic tumor was then palpated; an exploratory laparotomy was performed and the condition was found to be inoperable. A second intensive course in x-ray therapy was inaugurated, but the mass continued to grow rapidly and the patient died with liver and lung metastases two and one-half years after the primary operation. In five cases from the literature which were treated as fibroids because of a mistaken diagnosis, castration doses of x-ray failed to produce any change in the size of the tumor or a decrease in the uterine bleeding (cases of Schulze, Wolfe and Kaminester, Opitz, and von Szathmary, all quoted by Varangot).

Although the granulosa cell tumors present a uniform clinical syndrome, they do not represent a single pathologic entity. The first pathologic classification of the granulosa cell tumors was given by Meyer in his monograph of 1915. He divided the group into four subdivisions: (1) the macro- and microfollicular, (2) the diffuse, (3) the cylindroid, and (4) the sarcomatous. Since the appearance of Meyer's publication, authors almost universally have accepted his classification with the addition of two further subdivisions, "the folliculoma lipidique," sometimes referred to as the luteinized granulosa cell tumor; and the tubular granulosa cell tumor. The "fibroma theca cellulare xanthomatoides" of Löffler and Priesel has not been included as we consider that this tumor belongs to the sarcomatous group of Meyer.

The Micro- and Macrofollicular.—This type of granulosa cell tumor is one of the most easily recognized varieties as it bears the closest resemblance to the Graafian follicle. It is composed of small cells arranged concentrically about cystic spaces which frequently contain an eosin-staining substance. These folliculoid structures may be micro- or macroscopic in size. Call-Exner bodies are sometimes present. The connective tissue stroma, which is fairly abundant, shows an increased cellularity about the basement membrane of the follicles. The cells themselves have large nuclei and proportionately little cytoplasm. In places they seem to merge into the epithelioid cells of the folliculoid structures showing a striking resemblance to the cells of the theca interna (Fig. 6).

Grossly this tumor may appear to be completely solid, but more frequently it contains cysts which may vary from a few millimeters to over 10 cm. in diameter. On section the solid portions are composed

of cellular tissue of brainlike consistency which is yellow or sometimes even reddish in color. The cystic cavities may contain a coagulated gelatin-like material or a bloody serous fluid.

The Diffuse.—The diffuse type of granulosa cell tumor is similar to the micro- and macrofollicular type grossly. Microscopically it is characterized by solid insular areas of small cells which are roughly polyhedral in shape and have pale hematoxylin-staining nuclei with very little cytoplasm. There is a heavy connective tissue stroma surrounding these islands. The stroma is very acellular and hyalinization is occasionally seen. (Fig. 7.)

The Cylindroid.—This variety of tumor is composed of closely packed columns of small cells resembling those of the diffuse type. These columns are arranged in intricate patterns by a fine connective tissue network. (Fig. 8.)



Fig. 6.—Path. No. 58260. Microfollicular type of granulosa cell tumor, showing the lining of one small cyst and a more solid portion of the tumor with many Call-Exner bodies. The cell type resembles that seen in Fig. 3.

The Sarcomatous.—The sarcomatous type of granulosa cell tumor is the most difficult to recognize as it represents the most undifferentiated form. Grossly it is a solid tumor which resembles a fibroma of the ovary and on section shows a glistening white fibrous surface flecked with a yellow lipid material. Microscopically the cells are spindle in shape and arranged in whorls giving the watered silk appearance characteristic of connective tissue tumors. Giant cells, however, are rare, thus distinguishing them from true connective tissue sarcomas of the ovary. The tumor is cellular and toward the periphery a tendency to form minute follicles may be seen. Cholesterol crystals are frequently

present. This form is frequently confused with fibroma of the ovary and indeed the association with hyperestrinism is sometimes the only means of establishing a correct differential diagnosis. (Fig. 9.)

The cells of the sarcomatous granulosa cell tumor are apparently closely related to the theca cells and, therefore, the tumor has been described as a theca cell tumor. However, because its embryonic origin from the mesenchyme, its production of estrin, and its prognosis and treatment all are identical with those of the granulosa cell tumor, we prefer not to make a separate classification of such tumors.

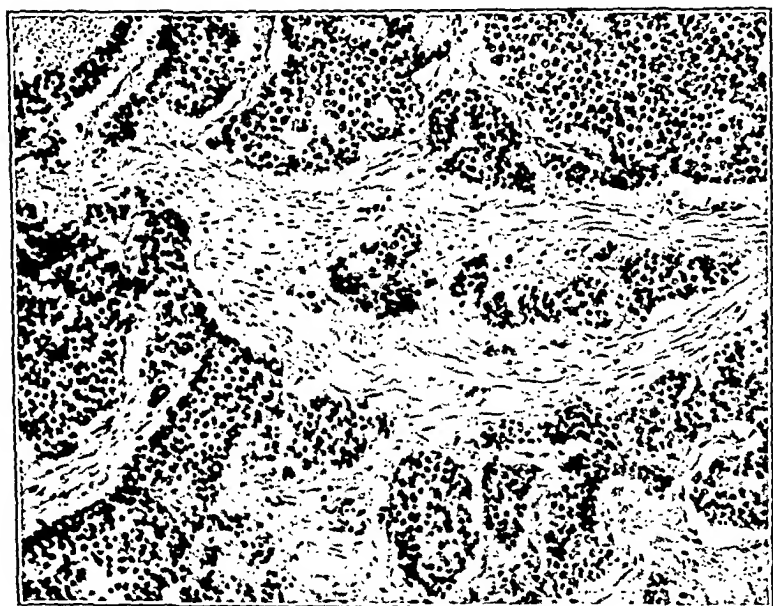


Fig. 7.—Path. No. 57980. Diffuse type, showing insular area of granulosa cells surrounded by a dense connective tissue stroma. The cell type resembles that seen in the more insular areas of Fig. 10.

The Tubular Type.—This form of granulosa cell tumor is extremely rare. It was recognized by Meyer and referred to as a granulosa cell tumor with unusual tubular areas. Microscopically it is composed of many small tubules of cuboidal cells with a clearly defined basement membrane and a secretory edge. The lumen of these small glands may or may not be filled with an eosin-staining material. There may be associated areas of solid tumor cells and also macrofollicular zones. (Fig. 10.) It is important not to confuse this type of tumor with the tubular testicular adenoma of Piek or more undifferentiated forms of arrhenoblastoma.

Varangot has described a case of this type in his monograph on granulosa cell tumors. His case was also clinically and physiologically a granulosa cell tumor.

The Folliculoma Lipidique.—The sixth type of granulosa cell tumor is also extremely rare, only three cases having been reported in the

literature. It was first described by Marion in 1910. Lecéne reviewed Marion's case and reported an additional case in 1927 (published by Moulonguet and Dobkevitch in 1931) and in 1933 Plate reported a third case.

The tumor is characterized grossly by a yellow color. Microscopically it resembles the diffuse type of granulosa cell tumor except for the

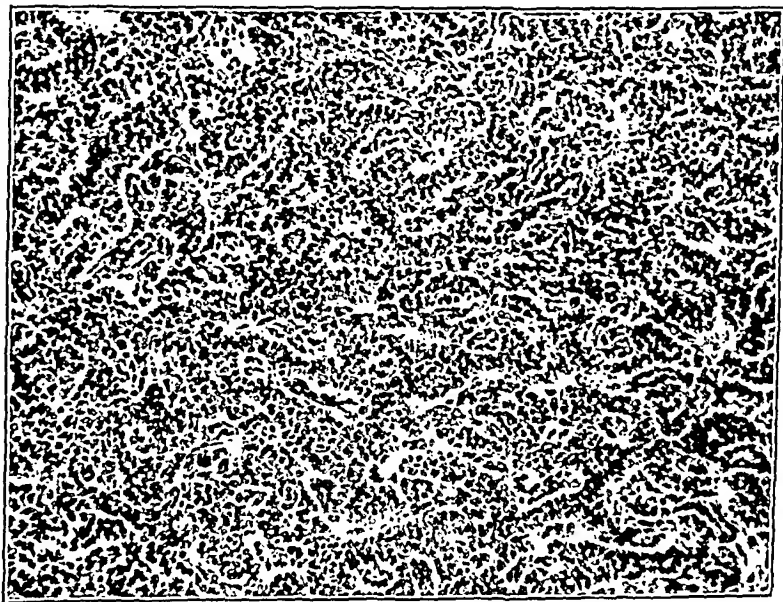


Fig. 8.—Path. No. 59136. Typical pattern of cylindroid granulosa cell tumor.

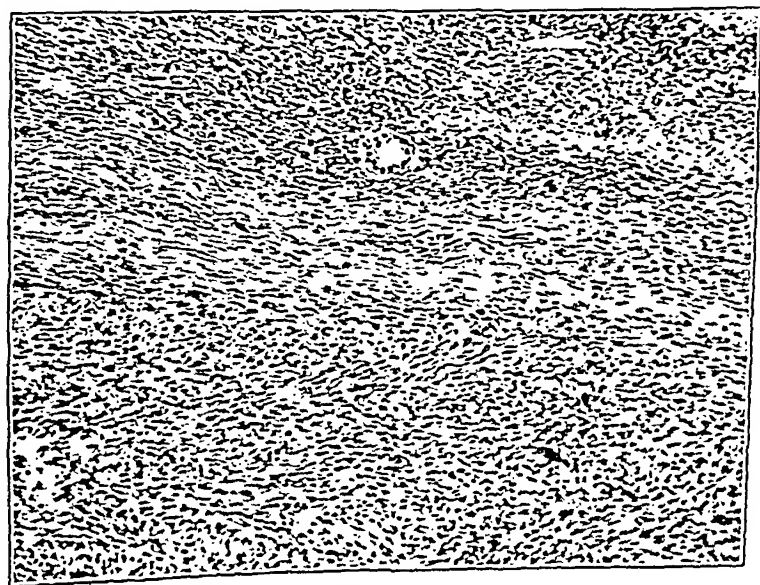


Fig. 9.—Path. No. 59143. Small follicle surrounded by spindle cells of a sarcomatous granulosa cell tumor.

abundance of lipoid material crowding each cell. This gives the tumor cells a certain resemblance to lutein cells and also to those of adrenal rest tumors. (Fig. 11.) Indeed, both Lecéne and Plate regarded it as a luteinized granulosa cell tumor; however, Varangot, who gives an excellent review of the subject, on the basis of physiologic evidence refuses to consider the tumor as such. The endometrium in Lecéne's

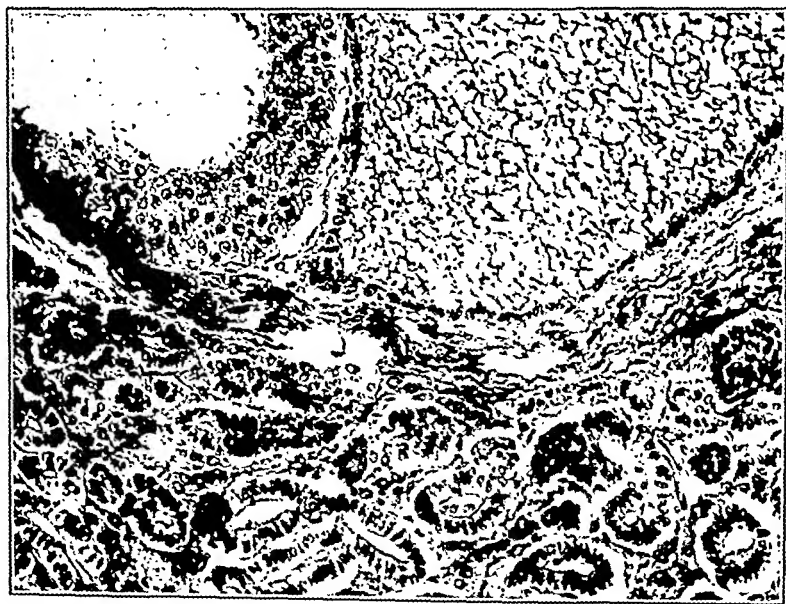


Fig. 10.—Path. No. 59686. Illustrating a tubular granulosa cell tumor having a micro-follicular area.



Fig. 11.—Path. No. 57570. Folliculoma lipidique showing abundant intracellular lipoid material.

cases showed hyperplasia and no secretory activity. Plate reports that the endometrium of his case was "très hyperplasique" with no further qualification. Therefore, physiologically the tumors can be classified as granulosa in origin, but cannot be considered as luteinized.

SUMMARY

Abnormal uterine bleeding in association with ovarian tumors has been analyzed as to cause and frequency in a group of 376 cases from the Surgical Pathological Laboratory of the Johns Hopkins Hospital and the Gynecological Service of the Church Home and Infirmary and the cases have been studied according to their pathologic classification. It has been found that abnormalities in menstruation occur among a variety of pathologic types of ovarian tumors but that the mechanism responsible for these abnormalities varies with the tumor type.

The highest occurrence of abnormal uterine bleeding was found in association with the tumors of granulosa derivation. It is this group which has been considered in the present paper. A group of 35 cases heretofore included under the classification of papillary serous cystadenocarcinoma has been added to the granulosa cell tumors as papillary granulosa cell carcinoma on the basis of morphologic and clinical characteristics. In 35 cases reviewed, 45 per cent were associated with abnormal uterine bleeding. A group of 59 solid granulosa cell tumors has been reviewed according to the pathologic type and 62 per cent were found to be associated with menstrual abnormalities. In both groups where endometrium was available, endometrial hyperplasia was the direct cause of the uterine bleeding. The hyperplasia is presumably produced by the estrogenic secretion of the tumor itself.

A more careful study of the uterine endometrium, together with hormonal studies on the blood and urine of patients with ovarian neoplasms, will render valuable assistance in the correct classification of ovarian tumors.

The authors wish to express their appreciation for the assistance and advice of Dr. Charles F. Geschickter and Dr. Vernon H. Norwood which have made this study possible.

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CYSTADENOMA OF THE OVARY INCORPORATED BETWEEN THE LEAVES OF THE MESOSIGMOID

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THE technical difficulties of removal are not great in the majority of instances of cystadenoma of the ovary. Adhesions to surrounding parietes, particularly to the intestines, are the most frequent causes of difficult surgical removal. In a review of 658 oophorectomies done for cystic and solid tumors, Spencer¹ found adhesions present in 448 (68 per cent).

So-called intraligamentary cysts developing between the leaves of the broad ligament were encountered in approximately 1 per cent of a series of 1,063 cases of ovarian tumor reported by Bernstein.² Considering the retroperitoneal origin of the ovary in close relationship with the mesonephros or embryonic kidney and its descent into the pelvis, where it becomes encased in its own mesentery, it is rather remarkable that the intraligamentary position is not more frequently encountered. This is borne out by the classical work of Dowd,³ who, in 1900, reported a case in which a cystic tumor had developed between the leaves of the transverse mesocolon. Microscopic examination of the cyst wall revealed its structure to be identical with that of ovarian cystadenoma, while chemical examination of its fluid contents indicated it to be strikingly similar to that found in ovarian cysts. Considering these points of similarity, together with the anatomical approximation of the root of the mesentery and the retroperitoneal origin of the ovary, Dowd expounded the theory that such mesenteric cysts develop from ovarian tissue sequestered from the main ovarian mass during its descent into the pelvis during embryonic life. He believed that mesenteric dermoid cysts probably arise from similarly sequestered ovarian tissue and pointed out that such sequestration is not infrequently encountered in other organs, notably the thyroid and spleen. He further recognized that mesenteric cysts whose walls have a microscopic structure similar to that of the intestine are probably a result of sequestration into the mesentery from the intestine. Dowd's views on the origin of mesenteric cysts have been widely accepted by present-day writers.⁴⁻⁶

Mesenteric cysts most frequently develop in the mesentery of the lower ileum, but they may occur in the mesentery of any part of the gastrointestinal tract, including the mesosigmoid. Conceding the correctness

cases showed hyperplasia and no secretory activity. Plate reports that the endometrium of his case was "très hyperplasique" with no further qualification. Therefore, physiologically the tumors can be classified as *granulosa* in origin, but cannot be considered as luteinized.

SUMMARY

Abnormal uterine bleeding in association with ovarian tumors has been analyzed as to cause and frequency in a group of 376 cases from the Surgical Pathological Laboratory of the Johns Hopkins Hospital and the Gynecological Service of the Church Home and Infirmary and the cases have been studied according to their pathologic classification. It has been found that abnormalities in menstruation occur among a variety of pathologic types of ovarian tumors but that the mechanism responsible for these abnormalities varies with the tumor type.

The highest occurrence of abnormal uterine bleeding was found in association with the tumors of *granulosa* derivation. It is this group which has been considered in the present paper. A group of 35 cases heretofore included under the classification of papillary serous cystadenocarcinoma has been added to the *granulosa* cell tumors as papillary *granulosa* cell carcinoma on the basis of morphologic and clinical characteristics. In 35 cases reviewed, 45 per cent were associated with abnormal uterine bleeding. A group of 59 solid *granulosa* cell tumors has been reviewed according to the pathologic type and 62 per cent were found to be associated with menstrual abnormalities. In both groups where endometrium was available, endometrial hyperplasia was the direct cause of the uterine bleeding. The hyperplasia is presumably produced by the estrogenic secretion of the tumor itself.

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Physical examination at the time of admission to the hospital revealed a well-developed and well-nourished woman, 30 years of age, who appeared to be in excellent health. A lower midline scar three and one-half inches in length was well healed except in the middle third where a separation of the fascia admitted the tip of the index finger. In the lower abdomen a mass approximately six inches in diameter could be felt extending from a little to the right of the midline well into the left lower quadrant. The mass appeared to be arising from the pelvis and extended upward to the level of the umbilicus. It was smoothly spherical in outline, nontender, and of a semifluctuant consistency which gave the impression that it was definitely cystic in character.

On bimanual examination the mass could be felt to arise from the left side of the pelvis. The fundus of the uterus could be definitely palpated, was of normal size and consistency and in an anterior position, although pushed somewhat to the right by the tumor mass. The latter was slightly movable in all directions, but it could not be moved freely in any direction. The right adnexa appeared to be entirely normal.



Fig. 1.—Barium enema study showing the upper half of the sigmoid colon displaced by an ovarian cyst which has developed between the leaves of the mesosigmoid. The distal half of the sigmoid lies coiled upon itself in the depth of the pelvis.

Barium enema studies (Fig. 1) revealed that the upper portion of the sigmoid was displaced upward and to the right by a rounded mass which extended upward from the true pelvis. The lower half of the sigmoid colon lay folded upon itself in the depths of the pelvis behind the tumor mass. The tumor appeared to be arising from outside the colon and caused no obstruction to its lumen.

Laboratory examination showed the urine to be normal. A mild hypochromic anemia was present with a red cell count of 3,900,000 and a hemoglobin content of 9.8 gm. per 100 c.c. The white cell count was 7,600 with a normal differential cell count. A slight achromia of the red cells was noted.

A preoperative diagnosis was made of cystadenoma of the left ovary with adhesions to the surrounding pelvic structures and to the sigmoid colon. Operation

of Dowd's theory that many mesenteric cysts arise from sequestrations from the ovary, we find reported in the literature a considerable number of such cysts in the mesentery of the sigmoid^{9, 10} although this is said to be the least common site.¹¹ For practical purposes such cysts are not and should not be classified as ovarian cysts. Herewith is reported a case in which a true cystadenoma of the left ovary developed between the leaves of the mesosigmoid. Report of a similar case has not been found in an extensive review of the literature.

CASE REPORT

The patient, a married woman, 30 years of age, was admitted to the Framingham Union Hospital on March 12, 1938, complaining of lower abdominal pain of two years' duration.

The past history is significant in that in 1915, at the age of 7½ years, she was treated at another hospital for pelvic abscess. At this time she gave a history of right lower quadrant abdominal pain of forty-eight hours' duration associated with nausea and vomiting. Marked tenderness was present in the right lower quadrant, with a white blood count of 17,600. Because of the presence of a rather marked acidosis, it was felt that her condition did not warrant immediate operation. She was therefore treated conservatively for twelve days, during which time her condition improved and her temperature, which reached a maximum of 105° F. at the beginning of her hospitalization, fell practically to normal. During this period she developed a tender mass in the lower abdomen which appeared to arise from the pelvis. The most prominent portion of the mass lay slightly to the left of the midline. She was operated upon through a lower midline incision. An abscess cavity was opened with the discharge of thick, odorless pus. The abscess was found to have several ramifications among the coils of small intestine, the main one reaching deeply into the pelvis on the left side and the other going superficially toward the region of the bladder in the median line. No mention was made in the hospital record as to the etiology of the abscess. The appendix was not removed, and the condition of the internal genitals was not noted. Following an uneventful post-operative convalescence, she was discharged from the hospital. When seen in the out-patient department of the same institution eight months later, her general health was noted to be good. There was a small hernia in the middle third of the operative scar.

Following this episode the patient enjoyed excellent health until the onset of her present illness. Her physical development was apparently normal. Menarche occurred at the age of 13 years. Menstrual periods have always been irregular varying from five to seven weeks with a rather scanty flow persisting for three days.

Two years ago, following an uneventful pregnancy, she was delivered of a normal male child. Following delivery she first noted the presence of a dull, dragging abdominal pain which was intermittent and definitely worse at the time of her menstrual periods. This discomfort progressively increased in severity. Three weeks before admission the patient fell against the corner of a table striking the lower abdomen in the region of the left lower quadrant. Following this she first noted a swelling of the lower abdomen and was conscious of a sensation of pressure in the lower abdomen and pelvis. She had one normal menstrual period following this episode. The patient had always been constipated, though this had been worse during the six months prior to admission. She also complained of hemorrhoids during this interval.

vessels lay between the medial leaf of the mesosigmoid and the wall of the cyst, the lateral leaf being relatively avascular.

The lateral leaf of the mesosigmoid was divided in a transverse direction and the plane of cleavage established between the peritoneum and the wall of the cyst. By means of blunt dissection, the wall of the cyst was completely freed both medially and laterally. Firm adhesions between the two layers made it necessary to use sharp dissection in many places, but the freeing-up process was eventually accomplished without injury to the sigmoidal vessels. The ovarian vessels descended retroperitoneally and entered the cyst in its posterior superior quadrant. They were doubly ligated and divided.

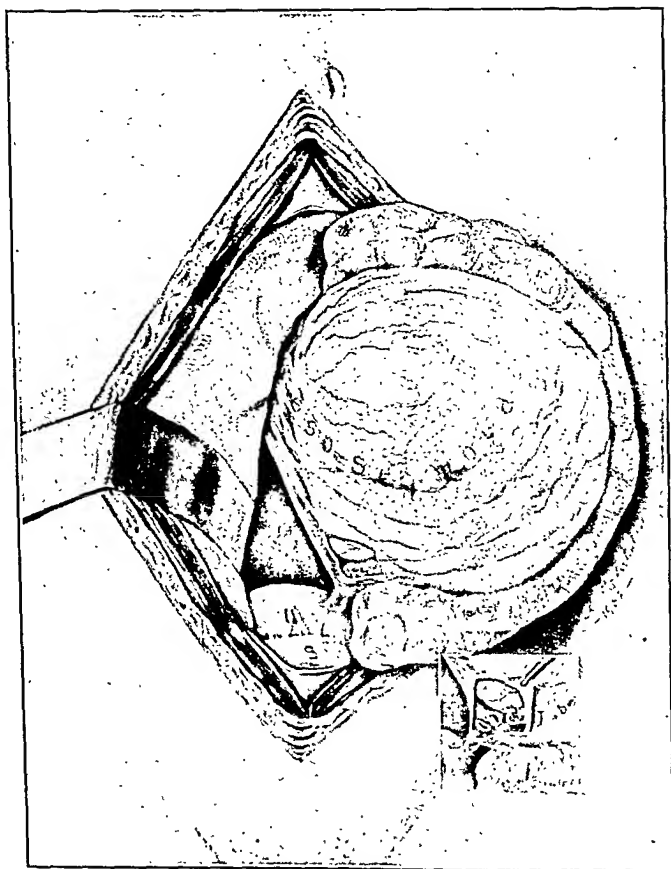


Fig. 3.—Medial relations of cyst. Note tube piercing medial leaf of mesosigmoid. Inset shows division of tube through a small incision in medial leaf of mesosigmoid.

After the cyst had been entirely freed, a small incision was made in the medial leaf of the mesosigmoid, just above the entrance of the tube. The tube and ovarian ligament were ligated and divided (inset Fig. 3) through this incision, and the cyst was removed through the incision in the lateral leaf. After careful hemostasis had been secured, the incisions in the two leaves of the mesosigmoid were sutured with catgut. The right tube and ovary appeared to be entirely normal and were not disturbed. The appendix was found to lie free in the right iliac fossa and was shorter and thicker than is usual with an irregular tip which suggested that a portion of the appendix had sloughed off during the childhood episode alluded to above.

was performed on March 5, 1938, through a midline incision extending from the symphysis pubis upward to the left of the umbilicus. The scar of the previous operation was excised. In the center of the scar was a small hernia through which a bit of omentum protruded. When the peritoneal cavity was opened, a cystic mass approximately six inches in diameter was found to extend from the brim of the true pelvis upward two-thirds of the distance to the umbilicus. The upper half of the sigmoid colon was adherent to the circumference of the cyst throughout all but its posterior quadrant (Fig. 2). Swinging the cyst and the attached sigmoid laterally revealed that the cyst was contained between the leaves of the mesosigmoid. Tough fibrous adhesions firmly bound the fundus of the uterus to the dome of the bladder.

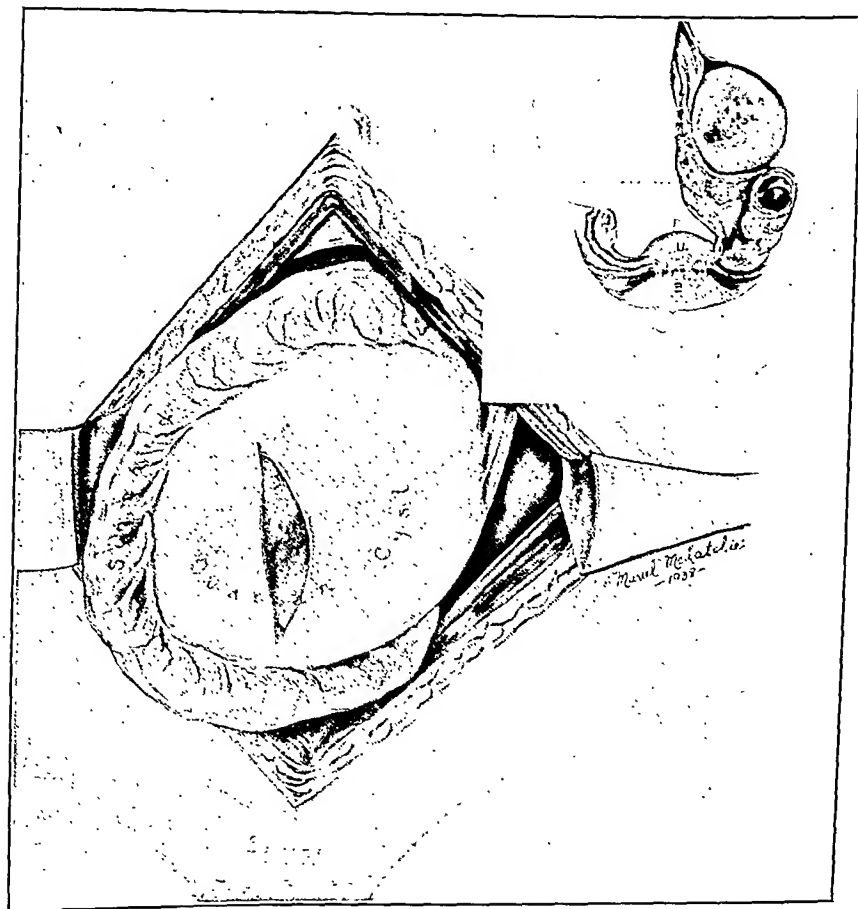


Fig. 2.—Incision in lateral leaf of mesosigmoid through which ovarian cyst was removed. Inset shows relation of structures involved.

The round ligament on the left side followed its normal course anterior to the bowel. From its point of insertion into the horn of the uterus, the left uterine tube proceeded posterior to the bowel and, along with the poorly-defined ovarian ligament, pierced the medial leaf of the mesosigmoid (inset Fig. 2) at a point about one-half inch from the uterus. The remainder of the tube, very much stretched and thinned out, was seen to course over the medial and anterior quadrants of the cyst beneath the medial leaf of the mesentery of the sigmoid (Fig. 3). The sigmoid

bowels had been regular without catharsis, and the lower abdominal discomfort had entirely disappeared.

Dr. S. B. Thorson, who examined the surgical specimen, reported: "The specimen consists of a cyst which has been previously opened and which measures 8 by 6 by 6 cm. In the wall of the cyst ovarian tissue is recognizable. The inner surface is smooth and reveals no papillary structures. A Fallopian tube measuring 9 by 0.7 cm. is present revealing numerous fibrous adhesions near the surface. The lumen is patent and reveals no exudate or fibrous adhesions. This tube extends along the wall of the cyst and finally is incorporated in it.

"Microscopic examination of the cyst wall [Fig. 4] shows it to be lined by a layer of flattened epithelium surrounded by what appears to be functioning ovarian tissue. Examination of sections through the Fallopian tube [Fig. 5] reveals no evidence of pathology in this structure.

"Microscopically the appendix shows evidence of an old, healed appendicitis with partial obliteration of its lumen. In addition there is slight, acute periappendicitis present."

DISCUSSION

That displaced ovarian tissue tends to undergo cystic degeneration is attested by the numerous published reports of cases of ovarian cyst developing between the leaves of the broad ligaments.¹²⁻¹⁴ How the ovary becomes misplaced to a position between the leaves of the broad ligament is a matter about which little comment is made in the literature. In speaking of dermoids of the ovary Graves¹⁵ states: "The majority of the tumors are well pedunculated and follow in their growth the usual path of migration (of the ovary) in the abdomen. Occasionally they may be intraligamentary, presumably when the point of origin was close to the hilum of the ovary." This may be the route whereby other types of cystic disease of the ovary assume an intraligamentary position. On the other hand, because of its retroperitoneal origin, it would seem logical to assume that in certain instances the ovary remains in a position between the leaves of the ligaments because formation of the mesovarium fails to take place or is incomplete. No data relative to this point have been found.

Because of the close anatomical association between the origins of the left broad ligament and the mesosigmoid from the parietal peritoneum, it is not difficult to imagine how a progressively enlarging intraligamentary cyst of the left ovary might dissect the peritoneum from the posterior abdominal wall in a lateral direction and finally come to assume a position between the leaves of the mesosigmoid.

In studying the anatomical relationships of the origins of the left infundibulopelvic ligament and the mesosigmoid, Cova¹⁶ found that the origins of the two were separated from each other by a distance of 2 to 3 cm. in 46 per cent of cases. In 15 per cent of cases the mesosigmoid and left infundibulopelvic ligament were found in contact with each other at their origin from the parietal peritoneum, while in 39 per cent the two formed at their origin a single peritoneal fold. It is in the latter group of cases that an enlarging intraligamentary left ovarian

The appendix was removed in the usual fashion and the abdominal wound was closed in layers without drainage.

The postoperative convalescence was entirely uneventful, the temperature never exceeding 100° F. and remaining normal after the third postoperative day. At no time did the patient exhibit symptoms or signs of ileus. The wound healed by first intention, and the patient was discharged from the hospital on the seventeenth postoperative day.

When seen six months after discharge from the hospital, she was feeling well and doing her housework without discomfort. Menstrual periods had been normal, the

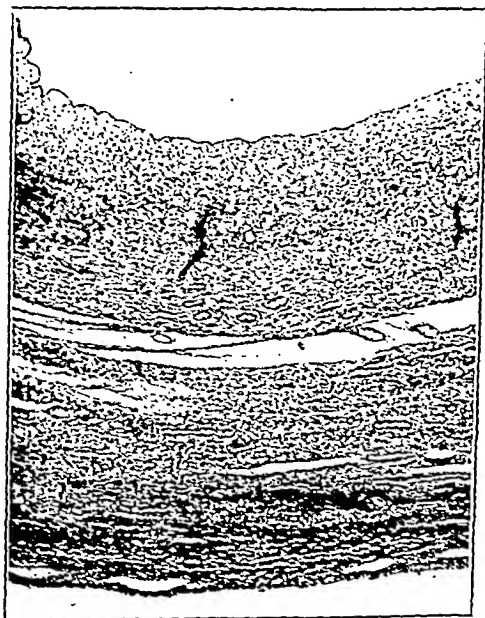


Fig. 4.—Photomicrograph of cyst wall showing lining of squamous epithelium.

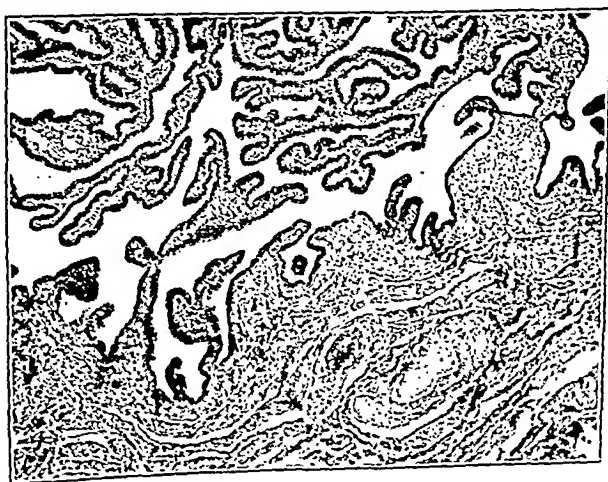


Fig. 5.—Photomicrograph of Fallopian tube, showing absence of pathology in this structure.

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cyst could most easily find its way to a position between the leaves of the mesosigmoid.

In speaking of intraligamentary ovarian cysts Berkeley and Bonney¹⁷ state that: "If the cyst starts between the ovarian and uterine vessels it forces its way upward until the ovarian vessels and Fallopian tube lie sessile on its upper surface and in close relation with each other.

"At a later stage the tumor grows backwards, progressively stripping the peritoneum and ureter from off the lateral pelvic wall so that the posterior layer of the broad ligament is gradually displaced toward the opposite side and in time the pouch of Douglas is entirely obliterated. When this happens, adhesion occurs between the contiguous peritoneal surfaces covering the cyst, the back of the uterus and the opposite broad ligament. During this process the cyst makes its way between the layers of the mesosigmoid and underneath the peritoneal covering of the rectum, until the bowel comes to lie sessile on its upper and inner surface."

It is altogether possible that the cystadenoma in the case herewith described dissected its way to a position between the leaves of the mesosigmoid in a manner similar to that described above. However, at operation the left tube and ovarian ligament appeared to perforate the medial leaf of the mesosigmoid. In view of the history of a pelvic abscess in childhood with a definite ramification to the left side of the pelvis, it seems more logical to assume that this abscess (or the surgery required for its drainage) in some manner injured the medial leaf and forced a herniation of the tube and ovary into a position between the leaves of the mesosigmoid. Because of its abnormal position, cystic degeneration followed. When the clinical history of the childhood illness and the present gross and microscopic findings are considered, it seems probable that appendicitis with perforation was responsible for the pelvic abscess.

SUMMARY

1. A case of cystadenoma of the left ovary lying between the leaves of the mesentery of the sigmoid colon is presented. In a fairly complete review of the literature, a similar case has not been found.
2. A pelvic abscess sustained in childhood is probably responsible for the unusual location of this cyst.
3. The origin of mesenteric cysts and of intraligamentary ovarian cysts is briefly discussed.

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lytic streptococci than any other department in the hospital except the Nose and Throat Department.

8. That *Staphylococcus aureus* is the principal and general source of infection of clinical wounds.

9. That these infecting agents gain direct entrance to the wound by precipitation from the air overlying the wound and by droplet infection.

10. That every wound made by the surgeon is contaminated and potentially infected in direct proportion to its size and the length of time of its exposure.

11. That a run of such cases always means that the air of the room contains, as proved by culture, a higher percentage of these organisms than normally.

12. That the percentage of viable bacteria reaching the wound may be greatly diminished, almost to the vanishing point, through appropriate continuous special ultraviolet radiation of the air and field of operation, with a resultant marked percentage reduction in the incidence of infected wounds.

13. That while the average incidence of such baleful clinical wound infections is from 4 to 6 per cent (heretofore recognized as an irreducible minimum) it at times rises to 18 to 20 per cent.

14. That a scientific bacteriologic checkup on every link in the so-called aseptic chain may achieve a 100 per cent credit, and yet the incidence of clinical wound infections continue at two to three times the average.

The work of Mason at the Northwestern University Medical School emphasizes the fact that it is within the power of the surgeon to change a contaminated, traumatic wound into a surgically purified one which generally will heal per primam without the use of any antiseptic whatever, provided soap may be so classified.

Inasmuch as every operative wound is contaminated and potentially infected, why should we not cleanse it in the same way?

Some to whom the idea was mentioned disparaged it as being an entirely unnecessary procedure, messy, and unsurgical, and stated it would soften the catgut, devitalize the cells, and violate the present great surgical principle of keeping the wound as dry as possible. However, it seemed entirely logical to conclude that, if contaminated, traumatic wounds with bruised, ragged, lacerated tissues containing grease and visible dirt by painstaking, careful débridement and thorough mechanical soap cleansing could be routinely transformed into wounds which would heal, in the great majority of instances, without infection; then surely the same cleansing process should be even more efficacious in nonlacerated wounds made by the surgeon which likewise, as proved, are always contaminated.

Our problem presented two outstanding questions.

A SIMPLE, EFFICIENT METHOD TO DIMINISH THE INCIDENCE OF PRIMARY AND SECONDARY INFECTION IN SURGICAL WOUNDS*

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ALL surgeons should be aroused to a renewed interest in the subject of infection of clinical wounds through the recent publication, among others, of the following papers: (1) "Sterilization of the Air in the Operative Region With Bactericidal Radiant Energy," by Hart and Gardner;² (2) "The Study of Wound Healing," by Reid;⁶ (3) "Is Adequate Masking Essential for the Patient's Protection?" by Davis;¹ (4) "The Surgical Principles Involved in the Treatment of Open Injuries," by Mason;⁴ and (5) "The Bacterial Flora of Clean Surgical Wounds," by Ives and Hirshfeld.³

From the scientific experiments of these workers, it is unequivocally apparent that, aside from all other long-recognized potential factors of infection of clinical wounds, such as contact infection from defectively sterilized hands, gloves, instruments, skin in the field of operation, sutures, ligatures, dressings, faulty hemostasis, rough handling of tissues, mass ligature necrosis, excessive bulk of catgut in ligatures and sutures, suturing which interferes with proper blood supply, use of strong antiseptic solutions with resulting necrosis or diminished functional repair ability of cells, there actually exists today in every operating room a most potent source of direct infection, one which strikes with a frequency and viciousness directly related to the following factors:

1. The number of human beings present in the operating room.
2. The frequency with which the room is used.
3. The time of year, the highest incidence of such clinical wound infections being coincident with high rate respiratory infections of humans.
4. That there are nearly always in the room carriers of *Staphylococcus aureus* or the hemolytic streptococcus.
5. That the surgeon, himself, unwittingly may be the carrier.
6. That it is practically impossible to guard against droplet infections without the use of impossible face and nose masks.
7. That practically all operating rooms contain, in the air and on the floors, walls, and ceilings, more staphylococci and, at times, hemo-

*Presented at the meeting of the Western Surgical Association, Omaha, Neb., Dec. 2 and 3, 1938.

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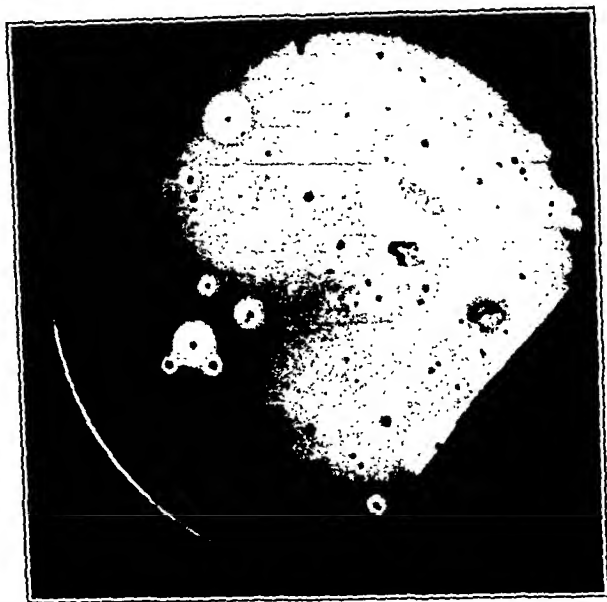


Fig. 2.—Hanging Petri dish culture exposed during surgical clinic; forty-eight-hour incubation.

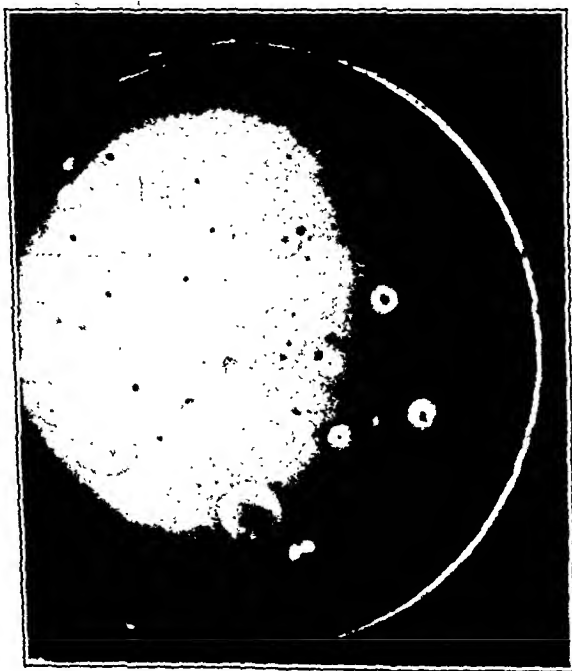


Fig. 3.—Another hanging Petri dish culture; forty-eight-hour incubation.

1. Will the same thorough cleansing with soap and water used in accidental wounds militate in any way against ideal healing if applied to clinical surgical wounds before closing them?

2. In a clinical wound proved by culture to be contaminated, what percentage of success in debacterialization may be expected by cleansing with soap and water?

1. However clean and aseptic an operating room appears, wound infecting organisms are always present in the air and on the walls.

A simple metal Petri dish support was devised to hang from a light bracket in the field of operation (Fig. 1). At three separate morning surgical clinics, blood agar Petri dish exposures were made for three hours.

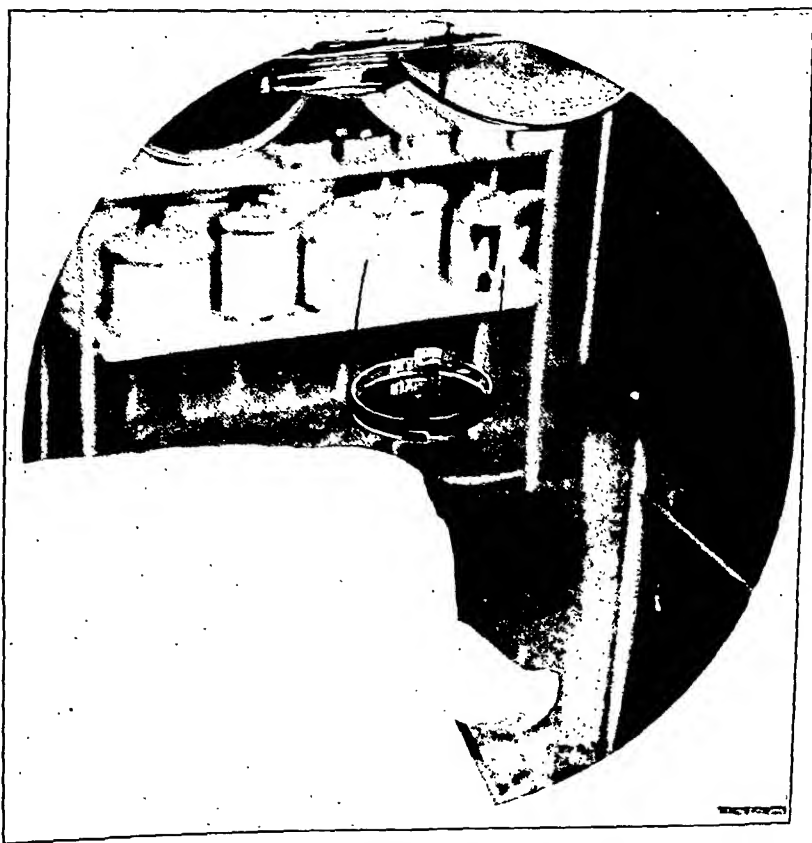


Fig. 1.—A simple Petri dish hanger suspended from operating light in field of operation.

Fig. 2 shows the result of one of the exposures after forty-eight hours of incubation. The other exposures were practically the same (Fig. 3). Aside from the identification of the presence of staphylococci and the hemolytic streptococcus, no effort was made to carry out

type of wound healing characterized by what might appropriately be termed the questionable stage during which, because of suspicious induration and signs of irritation, with slight elevation of temperature the surgeon has some anxiety as to just what will develop by the next dressing inspection. We are convinced that the debacterialization of the wound also removes wound detritus and blood which, if left, form sufficient nutrient material for the infecting organisms to give this expression of their presence before succumbing to the gathering forces of natural resistance of the individual patient. An appropriate term to describe the type of primary healing obtained by this method would be complete placidity.

The actual cleansing procedure and satisfactory end results were found in such major operative procedures as the following:* radical breast amputation for carcinoma, amputation of thigh for senile gangrene, cholecystectomy, open reduction of fracture of thigh, and Waugensteen's operation for a huge ventral hernia with utilization of a four-inch strip of fascia lata necessitating a twenty-inch thigh incision; both wounds healed perfectly.



Fig. 6.—After peritoneum is closed, sterile water is swished with a syringe into wound and 0.5 c.c. transferred to sterile nasal spray and cultured.

3. In a surgical wound proved to be contaminated, how much will soap cleansing debacterialize it?

In performing a splenectomy for a large primary hemangioendothelioma of the spleen, after closure of the peritoneum, 10 c.c. of sterile water is swished back and forth in the wound with a glass syringe (Fig. 6); then 5 c.c. of the wound fluid is withdrawn, placed

*Colored films depicting the actual cleansing procedure and satisfactory end results in such major operative procedures as those listed were shown in the presentation.

analytical percentage studies, as this work has been done repeatedly by others.

Ives and Hirshfeld,³ in a study of twenty-two similar exposure cultures, found:

Average percentage <i>Staphylococcus aureus</i>	6.9	} 88.4
Average percentage <i>Staphylococcus albus</i>	81.5	
Average percentage remainder, yeasts, molds, etc.	11.6	
	100	

A little dust was wiped from a wall with a gauze wet with sterile water and a little of the squeezed-out fluid sprayed into a blood agar Petri dish and incubated for forty-eight hours (Fig. 4).

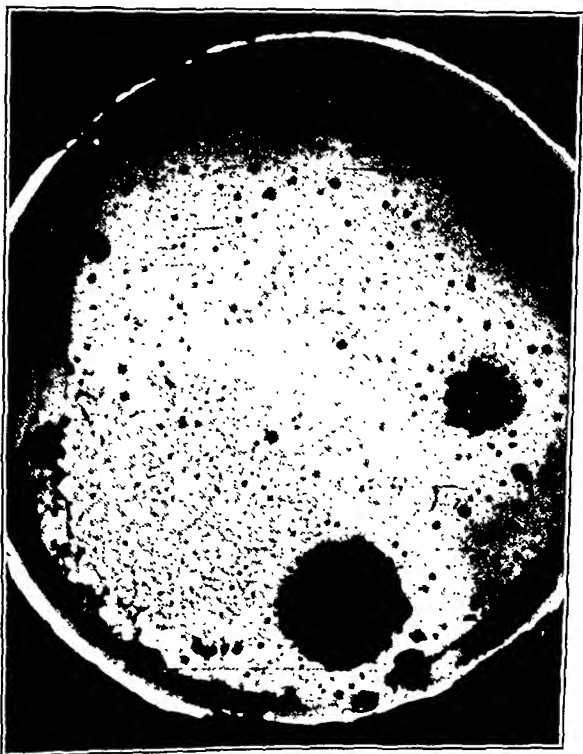


Fig. 4.



Fig. 5.

Fig. 4.—Culture of a little dust on operating room tiled wall.

Fig. 5.—Wounds thus treated uniformly heal kindly without any induration or irritation.

2. Gentle scrubbing of a surgical wound with soap and water before closure does not militate in the slightest degree against ideal healing.

This series of twenty-four routine laparotomy and other wounds indicated that gentle scrubbing with soap and water before closure did not interfere in any way with proper wound repair (Fig. 5). On the contrary, we believe from our experience that wounds thus treated heal uniformly most kindly in that there is a very noticeable lack of that

All bleeding points, no matter how small, are controlled by lightly touching with the point of the coagulating current, by pressure, or by ligation with the finest catgut. Perfect hemostasis is imperative.

Wound culture before cleansing	66 colonies
Wound culture after cleansing	4 colonies
A debacterialization of	93.8%

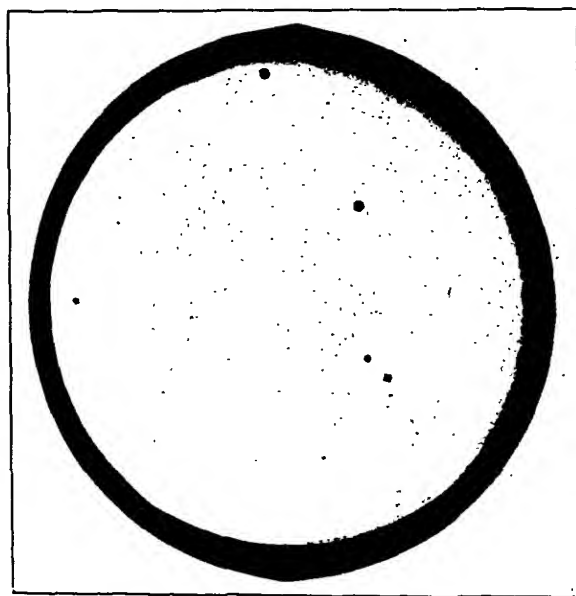


Fig. 8.—Culture from splenectomy wound after cleansing with soap and water.

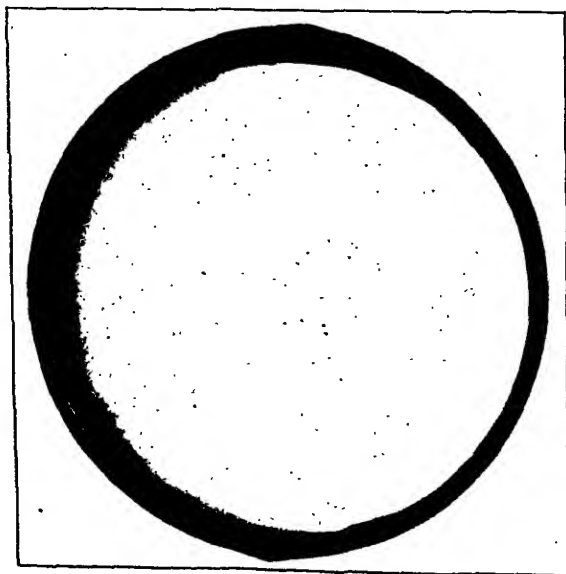


Fig. 9.—With increasing attention to minute details through routine practice, the percentage of negative plate cultures made after the wound cleansing will steadily increase.

in a sterile one-ounce nasal spray and 0.5 c.c. sprayed into a blood agar Petri dish. (After forty-eight hours' incubation, the culture appeared as shown in Fig. 7.)

The wound is then methodically cleansed, beginning at one end and completely cleansing the bottom and sides to the other end, with soap solution and sterile water. Ten cubic centimeters of sterile water is again swished in the wound, 0.5 c.c. of wound fluid sprayed into a blood agar Petri dish. (After forty-eight hours' incubation, the culture appeared as shown in Fig. 8.)

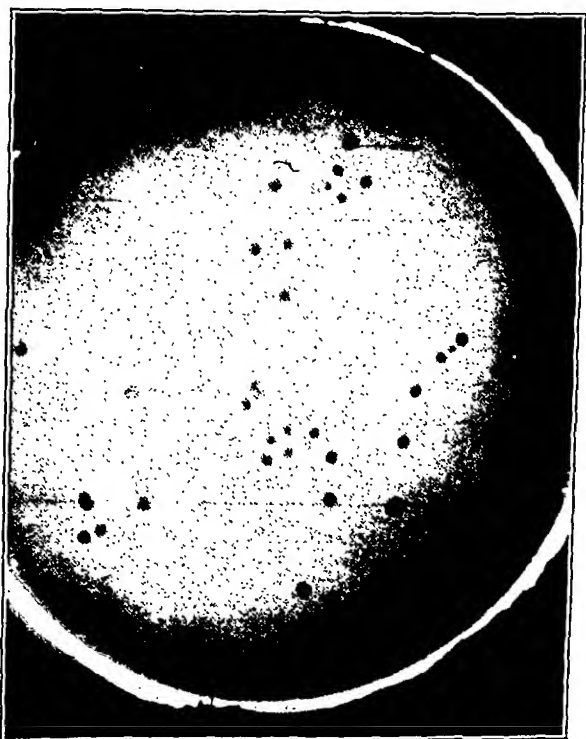


Fig. 7.—Culture from splenectomy wound before wound was cleansed with soap and water.

The wound is now packed with dry gauze and the wound lips closed over it with towel clips. The skin area around the wound is cleansed with soap and water, followed by alcohol sponging and painted with the surgeon's preferred dye. All drapes and instruments are removed.

The surgeon and assistants either put on fresh gloves or wash the ones they have on thoroughly with liquid soap and sterile running water. Fresh drapes are applied. A tray of freshly sterilized instruments and fresh suture material for closing the wound is properly placed. On no account should any instrument which has laid exposed on the reserve instrument table be used, as unquestionably particles of bacteria-laden dust have fallen on them and may be easily transmitted into the wound.

"After the opening of the Duke Hospital in 1930, at which time we were particularly anxious to avoid any unfavorable results in a new institution, we were confronted with a mounting percentage of infections in clean operative wounds. A most careful study of our aseptic technic, extending over two years, failed to show any flaw in the sterility of instruments, linen, ligatures, or other material used in the course of the operations.

"The greatest source of contamination was then most strikingly shown to be from the air. An attempt was made to free the operating rooms of these organisms (principally staphylococci) by exclusion and sterilization. Double doors were installed to prevent air currents from the wards. The carbolic spray was found ineffectual; the walls and ceilings were repainted, et cetera.

"The room so treated was found to be practically free from organisms. When occupied for the first operation, there was a rapid contamination of the air with staphylococci. We then showed that this contamination of the air with staphylococci at any place in the hospital or medical school was directly dependent on the number of occupants and the duration of occupancy."

Meleny⁵ recently has called attention to "the importance and present neglect of anaerobic bacteriology in the operating room." The cleansing of the wound as here described should conceivably diminish the chance that any such should remain to develop after wound closure.

The question may be raised: "Is it not possible that the remnant of soap left in the wound may act as a powerful germicide?" The soap that we have used through our experiments differs from the U.S.P. green soap in that in place of linseed oil the soya bean oil and corn oil are used with pure potassia. Cultures made with weak solutions of this soap show that bacteria thrive in it.

Inasmuch as it requires some experience to judge the proper strength of soap solution to be satisfactory as a cleansing agent and yet not be strong enough to blacken the tissues when used, we append here the directions followed by the operating room nurses in preparing it.

One pound of "operative" green soap* is thoroughly dissolved by boiling it in 4,000 c.c. of water, put in flasks, and autoclaved. Equal parts of this and sterile water are mixed together before using it at the operation; of this latter mixture, one or more ounces (depending on size of wound) is put in a suitable open top container and placed on the overhanging instrument rack available to the surgeon. Beside it are placed a vessel of sterile water and a pile of gauze sponges.

A gauze sponge is dipped first into the water and then lightly into the soap solution and applied to the wound. If the tissues tend to turn black, use less soap with the following swab. About a 6 per cent

*"Operative" green soap obtained from Theodore B. Robertson Products Company, Inc., 706-704 Division St., Chicago, Ill.

This, in our experience, may be considered a fair average. Naturally, the result will vary directly with the thoroughness with which the procedure is carried out.

In laparotomies where a hollow viscus has been opened and in cases of acute appendicitis, etc., cleansing should be done with especial thoroughness to diminish the chances of a colon bacillus wound infection. The more adept and thorough one becomes after using the method routinely, the larger the number of 100 per cent efficiency demonstrations.

Any possible infection of the wound in spite of it will depend largely on the quality of application by the individual surgeon of those surgical mandates which are imperative to obtain good wound repair, such as avoidance of (1) tension, (2) interference with blood supply, (3) unnecessary trauma, (4) excessive use of catgut, (5) mass ligation, and (6) imperfect hemostasis. The maximum amount of physiologic rest for the wound must be provided.

Ives and Hirshfeld³ state: "All wounds are heavily contaminated with bacteria presumably from the skin of the patient and the air of the operating room. Many of these organisms are known to be non-pathogenic, but the staphylococci form a not inconsiderable portion of the total. In spite of the presence of these bacteria, only about 5 per cent of the wounds become infected, so that factors other than the mere presence of bacteria, such as the resistance of the patient and the condition of the wound itself, must play an important role in the development of infection." "However," they add, "if the staphylococci as a group are responsible for the majority of wound infections, one may rightly assume that the contamination of wounds with these organisms is the cause of many postoperative wound infections. Our inability to reduce the incidence of infection below 5 per cent may well be due to neglect of this source of contamination."

Doubtless we have all had, time and again, a series of 100 or more cases in which there was not a single instance of wound infection, and we took pride in the fact that apparently there was no weak link in our aseptic routine. Yet, who among us has not had the nerve-racking, harrowing experience of a run of unexplainable, unwarranted, clinical wound infections? What a relief when the average incidence subsides to 4 or 5 per cent.

The experience of Hart and his colleagues is one which warrants constant repetition in the telling:²

"In 1925, confronted by a series of unexplained infections, a well known bacteriologist was asked to survey critically the entire operating room technic. He reported that there was no break in it to account for the infections. In this study, he completely ignored the air, including the dust in the air.

mary wound infection with these organisms averages 4 to 6 per cent, but at times may be as high as 20 per cent.

2. Every surgical wound develops a sticky fibrinous nutrient film which catches and holds bacteria and dust as would flypaper.

3. The amount of contamination and potential source of wound infection is directly proportional to the size of the wound and the length of time the air exposure continues.

4. Mechanical cleansing with soap and water just before closure of wound very efficiently and harmlessly removes this chance of primary wound infection with staphylococci, streptococci, etc.

5. The method actually aids in ideal wound repair as evidenced by the very high per cent of wounds healing with "complete placidity," no redness, induration, or irritation such as often seen and noted in wounds which just manage to pass muster as healing per primam.

We wish to acknowledge our indebtedness to Dr. W. D. Stovall, Director of the Wisconsin State Laboratory of Hygiene, for his sympathetic, cooperative suggestions and directions in the bacteriologic field.

April 1, 1939: We have continued throughout the winter and spring months to use this method. It is now routine in all operating rooms. Air cultures at times, due to upper respiratory infections in surgeons, nurses, and other operating room attendants, have shown terrific contamination, but primary wound infections have been practically nil; whereas, in the past during these seasons we have labored under a dreaded expectation of an appreciable rise in primary wound infections. Wound cultures after cleansing now show a very high percentage of negative results (Fig. 9). We are convinced that it is a harmless, inexpensive, efficient procedure and urge every surgeon, with the cooperation of a bacteriologist, to carry out the same convincing experiments.

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soap water solution contacts the tissues. We feel that a minimum cleansing time limit should be recognized and routinely make this two minutes by the clock for small wounds and may use up to five or more minutes in larger ones.

SUMMARY

The prime objective of this presentation was to demonstrate through personal experience that the cleansing with soap and water before closure of clinical wounds does not interfere in any way with ideal wound healing. We found this to be true in our series of over 200 consecutive wounds thus treated; there was no single instance of interference with primary wound healing due to it.

Another objective was to ascertain the relative value of the method in actually debacterializing a clinical wound. This we have found to be a variable quantity directly proportional to the thoroughness with which the procedure is carried out. A fair average would be 90 per cent efficiency. It must be remembered that the few seconds' exposure of the culture material to the air contamination, while transferring the wound washings after the cleansing, might permit of and be the direct cause of a few colonies developing after incubation.

As regards the incidence of secondary or hematogenous-borne wound infection, there were two instances in our series. One patient, ten days after a supravaginal hysterectomy, was found to have, in the lower end of the incision, a small broken-down, infected blood clot. This, we believe, was due largely to imperfect hemostasis before closing the wound. The other instance was that of a stitch abscess developed around a tension suture which the resident had overlooked and failed to remove until the fifteenth postoperative day.

While the problem of secondary clinical wound infections involves many imponderable factors, such as the general constitutional status of the patient and the presence or absence of a natural or inherited resistance to infection, we believe from the low incidence of secondary infection in our series that the mechanical cleansing in directly removing blood clots, broken-down fat cells, and wound detritus also greatly diminish the chance of a *locus minoris resistentiae* developing to form a nidus in which floating organisms may find lodgment with available nutrition and multiply. Every surgical wound develops a sticky, fibrinous nutrient film which catches and holds bacteria and dust as would flypaper. This mechanical cleansing removes it with all other wound detritus and thus not only diminishes the chances of infection but actually aids in ideal wound repair.

CONCLUSIONS

1. The air of every operating room is practically always badly contaminated with staphylococci and streptococci. The incidence of pri-

of the intervertebral disk of 1.08 mm. The semifluid invading disk material becomes transformed into cartilage by hyperplasia of its cartilage cells and is surrounded by vascular proliferation and engorgement and then by enchondral ossification which may extend into and involve the entire intervertebral disk. As shown by Püschel⁶ and by Keyes and Compere,⁷ the defects in the cartilage plate of the intervertebral disk open avenues for dehydration, with loss of the semifluid nucleus; the disk becomes narrowed and may disappear and the adjacent vertebral bone undergoes sclerosis and marginal proliferation. Fibrillation of the cartilage plate is analogous to the fibrillation of the cartilage of other joints which is characteristic of degenerative (osteo-) arthritis and, similarly, may be attributed to chronic stress and strain.

Identical changes have been reproduced in animals by Keyes and Compere, who noted (1) that, if the cartilage plate of the intervertebral disk of a dog was injured by a scalpel or drill, nuclear material prolapsed into the spongiosa of the adjacent vertebrae with the formation of typical cartilage nodes; and (2), if the nuclear material was allowed to escape, the rest of the disk became thinned out and the margins of the adjacent vertebrae hypertrophied and sclerosed. I have observed similar degenerative changes in three adult rabbits in which the lumbosacral disks were incised anteriorly and the nuclear content permitted to escape. This experience is supported clinically by Pease⁸ and Milward and Grout,⁹ who demonstrated narrowing of the intervertebral disk and localized osteoarthritis of the adjacent vertebrae following injury to the disks posteriorly during lumbar puncture.

Although Schmorl believed that protrusions of the intervertebral disk into the vertebral body were of no clinical significance, Schanz¹⁰ suggested the possible relationship between these prolapses and backache, and this belief has been supported by Mau,¹¹ Müller,¹² Dittrich,¹³ Calvé and Galland,¹⁴ Geist,¹⁵ Sashin,¹⁶ Joplin,¹⁷ Ayers,¹⁸ Keyes and Compere,⁷ and others. The relationship of narrowing of the intervertebral disk with secondary subluxations of and arthritic changes in the apophyseal (intervertebral) joints to backache and the sciatic syndrome has been stressed by Ayers,¹⁸ Williams,¹⁹ Hadley,²⁰ and Oppenheimer.²¹

The lumbar spines of 75 adult male human cadavers, aged 45 to 80 years, were sectioned in the midsagittal plane and the relation of the intervertebral disks, vertebral bodies, intervertebral foramina, neural arch, and ligamentum flavum to each other and to the contents of the spinal canal were studied. Narrowing of the intervertebral disk with fibrillation of the fibrocartilage and dehydration of the nucleus pulposus was noted between the fifth lumbar and first sacral vertebrae in 50 specimens; between the fourth and fifth lumbar vertebrae in 36 specimens; between the third and fourth lumbar vertebrae in 27; and between the second and third lumbar vertebrae in 19 specimens. These disk changes were associated in all specimens with varying amounts of

LESIONS OF THE INTERVERTEBRAL DISK AND LIGAMENTUM FLAVUM OF THE LUMBAR VERTEBRAE

AN ANATOMIC STUDY OF 75 HUMAN CADAVERS

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Philadelphia, Pa.)*

I. DEGENERATIVE LESIONS OF THE INTERVERTEBRAL DISK

IN A NORMAL adult intervertebral disk, the cartilage plate which overlies the cortical bone of the vertebral body, is intimately blended on its intervertebral surface with a layer of fibrocartilage which gives attachment to the fibers of the annulus fibrosus. The annulus serves as an envelope for the gelatinous, relatively incompressible nucleus pulposus. Most investigators believe that the disk is avascular, although Böhmig,¹ examining 70 vertebral columns from the embryonal state to the age of 30 years, found blood vessels in the intervertebral disks up to the age of 25 years; while Smith² demonstrated nutritive channels within the intervertebral disk which communicated directly with blood channels from the spongiosa of the vertebral body. Jung and Brunschwig³ found nerve fibers only in the anterior and lateral longitudinal ligaments; never within the disks.

A cross section of the disk in an infant reveals a gradual change from the hyaline type of cell at the periphery to an almost complete disappearance of cellular structure within its interior. There is a gradual loss of chondromucoid substance with isolated cartilage cells in its lacunae, and in the central portion of the disk are small clumps of cells which resemble prechondral tissue, the remaining notochordal cells. Microscopically, the adult disk shows a very loose network of fibrous tissue, in the meshes of which lie a profusion of connective tissue and cartilage cells.

The commonest lesion of the spine, according to Schmorl,⁴ is prolapse of the nucleus pulposus into the spongiosa of the vertebral body (Schmorl'sche Knötchen), which he found, single and multiple, in 38 per cent of several thousand spines removed at necropsy. The nuclear material is extruded through a defect in the cartilage plate, which may be developmental, traumatic, or infectious in origin, into the spongy bone of the vertebral body by external forces transmitted to the disk and by the turgor of the nucleus pulposus. Petter⁵ found that an average pressure of 30.2 pounds was required to reduce an average expansion

of the intervertebral disk of 1.08 mm. The semifluid invading disk material becomes transformed into cartilage by hyperplasia of its cartilage cells and is surrounded by vascular proliferation and engorgement and then by enchondral ossification which may extend into and involve the entire intervertebral disk. As shown by Püschel⁶ and by Keyes and Compere,⁷ the defects in the cartilage plate of the intervertebral disk open avenues for dehydration, with loss of the semifluid nucleus; the disk becomes narrowed and may disappear and the adjacent vertebral bone undergoes sclerosis and marginal proliferation. Fibrillation of the cartilage plate is analogous to the fibrillation of the cartilage of other joints which is characteristic of degenerative (osteo-) arthritis and, similarly, may be attributed to chronic stress and strain.

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Although Schmorl believed that protrusions of the intervertebral disk into the vertebral body were of no clinical significance, Schanz¹⁰ suggested the possible relationship between these prolapses and backache, and this belief has been supported by Mau,¹¹ Müller,¹² Dittrich,¹³ Calvé and Galland,¹⁴ Geist,¹⁵ Sashin,¹⁶ Joplin,¹⁷ Ayers,¹⁸ Keyes and Compere,⁷ and others. The relationship of narrowing of the intervertebral disk with secondary subluxations of and arthritic changes in the apophyseal (intervertebral) joints to backache and the sciatic syndrome has been stressed by Ayers,¹⁸ Williams,¹⁹ Hadley,²⁰ and Oppenheimer.²¹

The lumbar spines of 75 adult male human cadavers, aged 45 to 80 years, were sectioned in the midsagittal plane and the relation of the intervertebral disks, vertebral bodies, intervertebral foramina, neural arch, and ligamentum flavum to each other and to the contents of the spinal canal were studied. Narrowing of the intervertebral disk with fibrillation of the fibrocartilage and dehydration of the nucleus pulposus was noted between the fifth lumbar and first sacral vertebrae in 50 specimens; between the fourth and fifth lumbar vertebrae in 36 specimens; between the third and fourth lumbar vertebrae in 27; and between the second and third lumbar vertebrae in 19 specimens. These disk changes were associated in all specimens with varying amounts of

lippling and spur formation of the adjacent margins of the vertebrae (Figs. 1 and 2). In 2 specimens the disks between the third, fourth, and fifth lumbar and first sacral vertebrae were expanded and associated with porosity of the vertebral spongiosa (Fig. 1*d*). Schmorl attributed such disk changes to the turgor of the nucleus pulposus; Moffat²² believed these expansions of the disk to be due to hypertrophy and proliferation of its cellular elements. Protrusions of the intervertebral disk into the vertebral body (Schmorl's nodes) were found extending into the third lumbar vertebra in 6 specimens, into the fourth lumbar vertebra in 4 specimens, into the fifth lumbar vertebra in 2 specimens, and into the first sacral vertebra in 1 specimen. This occurrence was multiple in the same specimen in 3 instances and single in 4 specimens (Figs. 2 and 3).

Forward displacement of a vertebra on the vertebra below, associated with bilateral pedicle defects (anterior spondylolisthesis), was present in 5 specimens: between the fifth lumbar and first sacral vertebrae in 2, between the fourth and fifth lumbar vertebrae in 2, and between the third and fourth lumbar vertebrae in 1 (Fig. 4). The intervertebral disk at the site of the anterior spondylolisthesis was narrowed or almost absent and there was considerable bony proliferation of the supero-anterior margin of the body of the lower vertebra, acting as a shelf to support the slipping vertebra above. The posterosuperior margin of the lower vertebra produced a prominent intraspinal protrusion, yet in no instance was there abnormal tension on the caudal nerve roots. The neural canal is large in this region and permits considerable shift of the roots of the cauda equina.

Posterior displacement of the fifth lumbar vertebra on the sacrum has been described by Ferguson²³ and his associates as a cause of low back pain, the lesion having been demonstrated in 235 (20.3 per cent) of 1,157 patients with low back and sciatic pain (Kimberley²⁵). This displacement measures from $\frac{2}{16}$ to $\frac{7}{16}$ inch (Smith²⁴). These authors differentiate the developmental type, associated with an unstable fifth lumbar vertebra, from the acquired type, due to true atrophy of the intervertebral disk. In my series the posterior margins of the fifth lumbar vertebra extended posterior to that of the sacrum for a distance of $\frac{2}{16}$ to $\frac{4}{16}$ inch in 9 specimens and was associated with degenerative changes and narrowing of the lumbosacral intervertebral disk and with marginal proliferation (Fig. 5). There was a settling of the fifth lumbar vertebra downward and backward, and this posterior displacement was made more apparent by bony proliferation at the postero-inferior margin of the fifth lumbar vertebra. In no instance was there an associated defect in the neural arch, vertebral body, or its accessory processes, and in only one instance were the planes of the lumbosacral facets less than 45 degrees from the sagittal plane of the body.

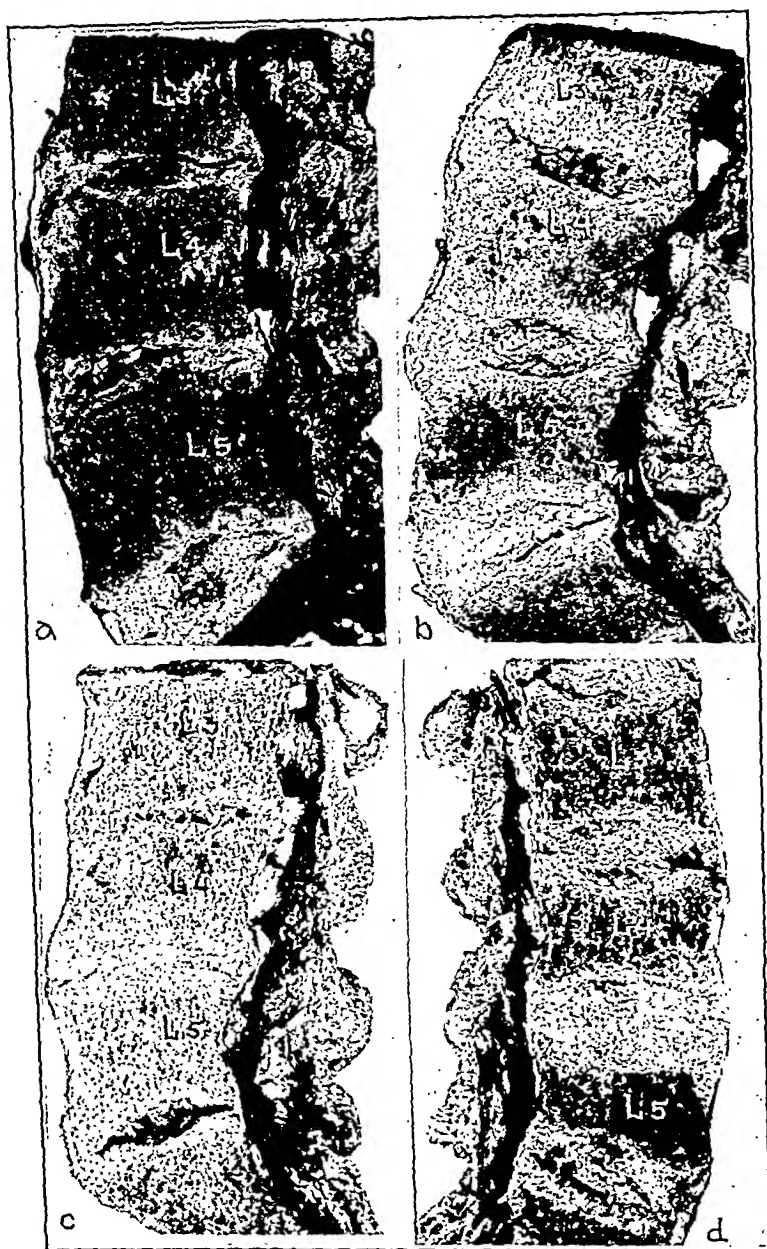


Fig. 1.—Lumbar spine, midsagittal sections. *a*, Fibrillation, dehydration, brown pigmentation, and narrowing of the intervertebral disks, associated with marginal bony proliferation and with protrusion of the disks posteriorly into the spinal canal. *b*, Similar changes to those shown in *a*, associated with sclerosis of the adjacent borders of the vertebral bodies, especially marked at the inferior border of the third lumbar vertebra. *c*, Narrowing, dehydration, and fibrillation of the intervertebral disks, with bony fusion between the third and fourth lumbar vertebral bodies due to ossification of the anterior one-third of the corresponding disk. *d*, Expansion of the intervertebral disks, especially marked between the fourth and fifth lumbar vertebrae, and associated osteoporosis and compression of the vertebral bodies.



Fig. 2.—Lumbar spine, midsagittal sections. *a*, Narrowing, dehydration, and brown pigmentation of the intervertebral disk between the fourth and fifth lumbar vertebrae, with sclerosis of the adjacent vertebral margins. *b*, Protrusion of the intervertebral disk into the inferior portion of the third lumbar vertebra and protrusion of the disk between the fourth and fifth lumbar vertebrae posteriorly into the spinal canal. *c*, Protrusion of the intervertebral disk into the inferior portion of the body of the third lumbar vertebra with surrounding bony sclerosis. *d*, Protrusions of the disk into the superior portion of the bodies of the third and fourth lumbar vertebrae.

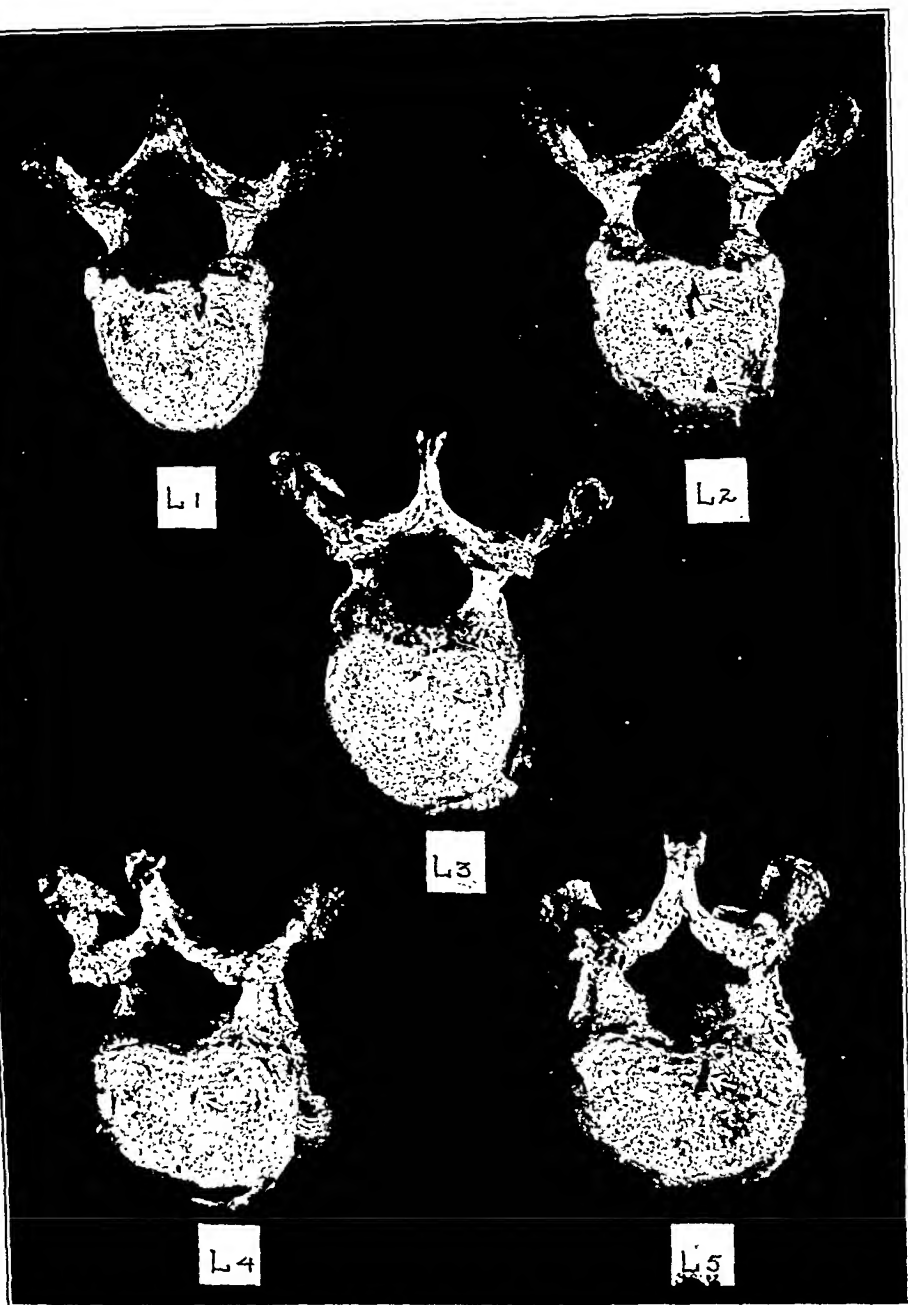


Fig. 3.—Defects in the inferior surfaces of macerated lumbar vertebrae from the same specimen due to intervertebral disk protrusions into the spongiosa. The rim of bone, present anteriorly and laterally but not posteriorly, is the epiphyseal ring which has fused with the vertebral body.

The histories of 25 cases in this series of 75 specimens were reviewed. Although there were narrowed disks in 24 cases, protrusions of the disk into the vertebral bodies in 4, and posteriorly into the spinal canal in 9, backache was an infrequent and minor complaint in this series, and in no instance had the patient experienced the sciatic pain syndrome.

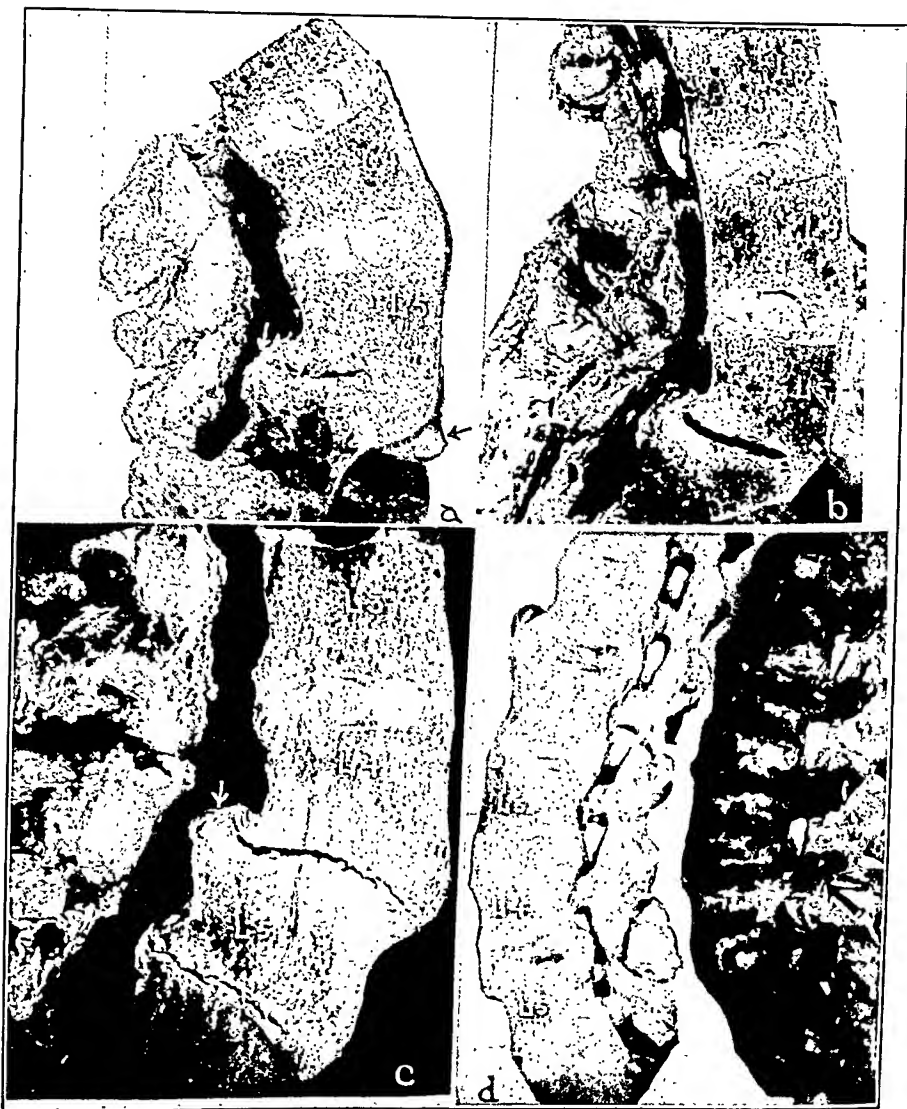


Fig. 4.—Lumbar spine, midsagittal sections. *a*, Anterior spondylolisthesis of the fifth lumbar vertebra with marked narrowing of the lumbosacral disk, bony proliferation of the anterosuperior margin of the first sacral vertebra, and encroachment on the spinal canal by the hypertrophied posterosuperior margin of the first sacral vertebra. *b*, Anterior spondylolisthesis of the fifth lumbar vertebra. *c*, Anterior spondylolisthesis of the fourth lumbar vertebra. The corresponding disk has disappeared and the adjacent vertebral bodies are in direct contact and markedly sclerosed. Encroachment on the caliber of the spinal canal by the hypertrophied posterosuperior border of the fifth lumbar vertebra is apparent. *d*, Anterior spondylolisthesis of the fourth lumbar vertebra. The site of the pedicle defect is marked by an arrow.

II. POSTERIOR PROTUSIONS OF THE INTERVERTEBRAL DISK

Kocher²⁶ in 1896 reported a case of ruptured intervertebral disk without cord compression in a man who had died of injuries following a fall from a height of 100 feet. In 1911 Middleton and Teacher²⁷ and Goldthwait²⁸ reported cases of cord compression due to changes in the intervertebral disks. Extradural tumors arising from the intervertebral disk have been described variously as "intervertebral disk chondroma"



Fig. 5.—Midsagittal sections. The posterior border of the fifth lumbar vertebra in all the specimens lies posterior to the corresponding border of the first sacral segment, the posteroinferior border of the fifth lumbar vertebra constituting a definite protrusion into the spinal canal. There are degenerative changes in the intervertebral disks, especially at the site of "posterior displacement"; i.e., the lumbosacral disks.

by Bailey and Bucy,²⁹ "ventral extradural chondroma" by Stookey³⁰ and Adson,³¹ "myxochondroma" by Veraguth,³² "fibroma" by Alajouanine and Petit-Dutailis,³³ "fibro-chondroma" by Crouzon, Petit-Dutailis, and Christophe³⁴ and by Ott and Adson,³⁵ "Schmorl's nodule" by Klinge,³⁶ Kortzeborn,³⁷ and von Péchy,³⁸ "loose cartilage from the intervertebral disk" by Dandy³⁹ and "ecchondrosis" by Elsberg.⁴⁰

The conception of these lesions as posterior herniations of the nucleus pulposus was initiated by the researches of Andrae⁴¹ and Schmorl.⁴² Andrae found 56 cases of posterior nodules of the intervertebral disk in 368 spines (15.2 per cent), appearing as small, pea-sized projections on the anterior surface of the spinal canal, 20 in males and 36 in females. There were none in patients below 30 years of age and the majority were in patients above 50 years of age. In 25 cases there were more than one nodule and as many as 7 nodules occurred in a single specimen. Andrae demonstrated direct communications between the nucleus pulposus and posterior disk protrusion in 16 specimens. Neither he nor Schmorl attributed clinical significance to these lesions.

Due largely to improvement in diagnostic measures, especially in the use of iodized oil intraspinally,⁴³⁻⁴⁶ large series of these lesions causing cord or nerve root compression have been reported by Love and Walsh⁴⁷ (113 posterior disk protrusions in 100 patients),^{*} Barr⁴⁸ (83 cases), Glorieux⁴⁹ (25 cases), Fincher and Walker⁵⁰ (24 cases), Haggart⁵¹ (25 cases), Poppen⁵² (23 cases), and small series by Peet and Echols,⁵³ Slaughter,⁵⁴ Sherwood and Berens,⁵⁵ Paltrinieri,⁵⁶ Simonds,⁵⁷ Flothow,⁵⁸ Furlow,⁵⁹ Steele,⁶⁰ and others. Botts⁶¹ found posterior protrusions of the intervertebral disk into the spinal canal in 16 per cent of 50 human cadavers.

In my series of 75 adult lumbar spines, unilateral posterior herniations of the nucleus pulposus were demonstrated in 4 instances: one between the second and third lumbar vertebrae ($\frac{1}{4}$ inch in diameter), one between the third and fourth lumbar vertebrae ($\frac{1}{2}$ inch in diameter), one between the fourth and fifth lumbar vertebrae ($\frac{1}{4}$ inch in diameter), and one arising from the lumbosacral disk ($\frac{3}{16}$ inch in diameter). Posterior bulging of the annulus fibrosus of the disk across its entire width, without true herniation, and formed in great part by the hypertrophied posterior margins of the adjacent vertebrae, was found in 21 instances between the fifth lumbar and first sacral vertebrae, 19 instances between the fourth and fifth lumbar vertebrae, 9 instances between the third and fourth lumbar vertebrae, and once between the second and third lumbar segments. In each instance there were associated degenerative changes throughout the intervertebral disk (Fig. 6).

Camp and Barr in their large series of cases found the association of narrowing of the intervertebral disk with marginal bony proliferation

*In a more recent report by these authors, this series includes 200 cases (Walsh, M. N., and Love, J. G.: The Syndrome of the Protruded Intervertebral Disk, Proc. Staff Meet., Mayo Clin. 14: 230, 1939).



Fig. 6.—a, Posterior view of the vertebral bodies and intervertebral disks; b, lateral midsagittal view of the same specimen. There are posterior protrusions of the intervertebral disks between the second, third, fourth, and fifth lumbar vertebrae, associated with degenerative changes throughout the entire disks. A large intraspinal protrusion, measuring $\frac{1}{2}$ inch in diameter and extending $\frac{3}{16}$ inch posteriorly, involves the intervertebral disk between the third and fourth lumbar vertebrae to the left of the posterior longitudinal ligament. c, Midsagittal section; posterior protrusion of the lumbosacral intervertebral disk with encroachment of the spinal canal. d, Midsagittal section; posterior protrusion of the intervertebral disks between the fourth and fifth lumbar and the fifth lumbar and first sacral vertebrae. The intervertebral disks show advanced degenerative changes.

(roentgenographic) and the site of the posterior disk protrusion frequent but not constant enough to be of significance to them. The association of these two lesions may be more definite than is apparent in their investigations, when one realizes that roentgenographic evidence of intervertebral disk changes becomes manifest relatively late in the degenerative process and only after narrowing of the intervertebral space, calcification of the disk, or marginal bony proliferation have occurred (Horwitz and Smith⁶²).

In no instance, in my series, was a spinal nerve unduly compressed either within the spinal canal or at its exit through the intervertebral foramen, although the caliber of the latter frequently was diminished by the bulging disk. It is true that the relation of nerve to adjacent structures might become altered in the cadaver, but the histories of nine cases with evidence of posterior protrusion of the intervertebral disk were reviewed and in no instance had the patient experienced marked backache or the sciatic pain syndrome.



Fig. 7.—Midsagittal sections; anterior protrusion of the lateral portion of the ligamentum flavum (left), between the fifth lumbar and first sacral vertebrae, encroaching upon and narrowing the intervertebral foramina. These protrusions were found to be due to hypertrophic changes in the underlying articular facets of the apophyseal joint and not to actual hypertrophy of the ligamentum flavum.

Microscopic studies of 100 specimens of posterior disk protrusions by Deucher and Love⁶³ revealed annulus fibrosus and parts of the nucleus pulposus in all and the presence of notochordal cells in many. Grossly, two types have been noted, those that "pop out" when the dura is incised anteriorly and those that are firmly adherent and are removed with great difficulty. From an analysis of their pathologic studies, it becomes evident that the term "posterior protrusion of the intervertebral disk" is more accurate than that of "posterior herniation of the nucleus pul-

posus," and that the older concept of these lesions as representing extradural neoplasms arising from the cartilaginous elements of the disk posteriorly should not be entirely discarded.

III. STUDIES OF THE LIGAMENTUM FLAVUM

Extradural lesions due to hypertrophy of the ligamentum flavum first were described by Elsberg^{64, 65} in 1913 and 1916 and have been reported by Towne and Reichert,⁶⁶ Punsopp,⁶⁷ Abbott,⁶⁸ Hampton and Robinson,⁴⁴ Spurling, Mayfield, and Rogers,⁶⁹ Naffziger, Inman, and Saunders,⁷⁰ Brown,⁷¹ and Meredith and Lehman.⁷²

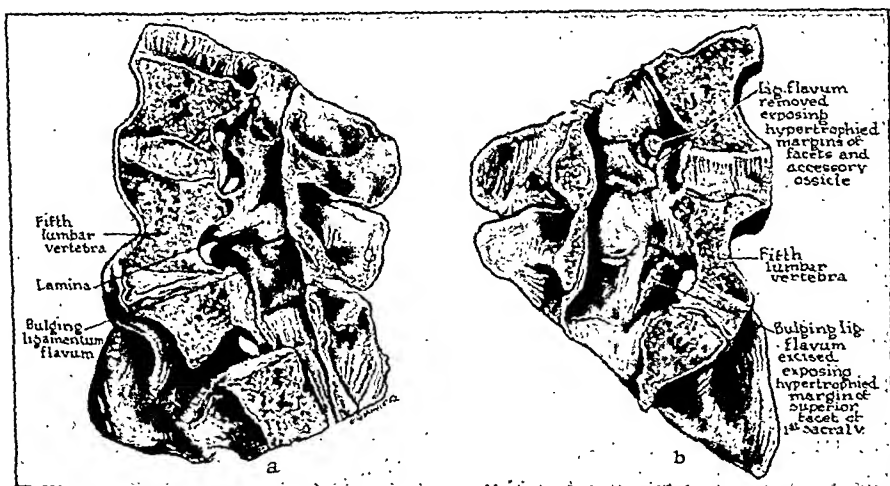


Fig. 8.—The lesion shown in Fig. 7 is illustrated in two other specimens, before (a) and after (b) removal of the normal ligamentum flavum overlying the protrusion.

The ligamentum flavum bridges contiguous laminae, blending in the midline with the interspinous ligament, and laterally enters into the formation of the anterior capsule of the corresponding apophyseal joint. In the lumbar spine the upper portion of the intervertebral foramen is traversed by the spinal nerve, while the lower portion is a mere slit, bounded in front by the intervertebral disk and behind by the ligamentum flavum. The spinal nerve may be compressed either as it descends, medial to this slit, to leave through the intervertebral foramen below, or within the foramen itself. It has been suggested that the ligamentum flavum hypertrophies due to injury and scar tissue formation, and in almost all instances this lesion has been reported as involving the interspaces between the fourth and fifth lumbar and the fifth lumbar and first sacral vertebrae and has measured from 8 to 16 mm. in thickness. Microscopic studies have shown little except thickening of the vessel walls, fibrosis, areas of blood pigment, and calcification. Spurling and his co-workers described an associated hypertrophy of the lamina, but this has not been confirmed by other observers. The association of

hypertrophy of the ligamentum flavum with posterior protrusion of the intervertebral disk has been noted by Brown,⁷¹ Bell and Spurling,⁴⁶ and Love.⁷³

In order to determine the normal variations in thickness of the ligamentum flavum Spurling, Mayfield, and Rogers measured this structure in the region of the midlamina in 40 human cadavers, and these measurements have been repeated by me in 21 specimens.

TABLE I

		INTERSPACE				NO. OF CADAV- ERS
		2-3L	3-4L	4-5L	5L-1S	
Thickness of ligamentum flavum (Spurling and co-workers)	Minimum	-	2.0 mm.	2.0 mm.	2.0 mm.	40
	Maximum	-	7.0	7.0	7.0	
	Average	-	4.3	4.4	4.2	
Horwitz' series	Minimum	2.0 mm.	2.0 mm.	1.5 mm.	2.0 mm.	21
	Maximum	4.5	5.0	6.0	6.0	
	Average	3.5	3.5	3.8	3.6	

In no instance in my series did the ligamentum flavum exert undue pressure on the caudal nerve roots. Apparent forward bulging of the ligamentum flavum, which constricted the intervertebral foramen, was found between the fifth lumbar and first sacral vertebrae in 4 specimens on the right side and in 3 specimens on the left, and between the fourth and fifth lumbar vertebrae in 2 specimens on the right side. This bulge was found to be due to advanced marginal proliferation of the articular facets of the apophyseal joints and not to hypertrophy of the overlying ligamentum flavum. (Figs. 7 and 8.)

CONCLUSIONS

Recent clinical reports indicate that posterior protrusion of the intervertebral disk and hypertrophy of the ligamentum flavum are extradural lesions which are not infrequent causes of low back and sciatic pain syndromes. Since the diagnosis of these cases depends not only on abnormal neurologic and spinal fluid findings, but in great part on the use of contrast myelograms, it is important to understand that other lesions, largely the result of degenerative processes and also involving the intervertebral disk and ligamentum flavum and their adjacent structures, may be asymptomatic and yet produce defects in the intraspinal column of air or iodized oil.

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CELLOPHANE AS A WOUND DRESSING

EDWARD L. HOWES, M.D., WASHINGTON, D. C.

STERILIZED cellophane is an excellent dressing for clean wounds. It has several advantages not possessed by ordinary gauze: (1) the wound may be inspected repeatedly for evidence of infection without the necessity of changing the dressing; (2) accurate palpation of the length of the incision may be carried out at any time without contaminating the wound; (3) it does not stick to the wound crust and consequently may be removed without distressing the patient; (4) it is extremely economical; (5) it is more impervious to external bacterial contamination than gauze; and (6) the amount of seepage and hemorrhage occurring during the first twenty-four hours may be seen and used as a measure to perfect the surgical technique.

No. 600 plain cellophane with thickness of 0.0017 inch has been found to be the most satisfactory grade and is best prepared by autoclaving. The sheet is cut in a rectangle of the desired size at the operating table, and the wound and surrounding skin swabbed with ether to render it as dry as possible. The sheet is then placed directly over the incision and fastened into place by a border of adhesive plaster on all four sides. The adhesive plaster is placed half on the skin and half on the cellophane, sealing down the edges. Small droplets of blood and moisture, partially obscuring vision, accumulate on the inside of the sheet within the first few hours, but drying takes place during the next twenty-four to thirty-six hours if adequate hemostasis was obtained at the time of operation. A heat lamp is frequently applied to the abdomen to aid drying, for the comfort it gives to the patient and because the resulting vasodilatation aids healing.¹ An air vent may be left at one corner if desired, but it will not prevent the transitory steaming.

The vent should always be made after twenty-four hours if the collection is excessive, for the dry state is more conducive to healing per primam than the wet. as John Hunter pointed out long ago. A small square of gauze is then placed over this opening to prevent soiling of the bedclothes. Excessive collections of fluid were only found when hemostasis was inadequately obtained or when the wounds were going to have untoward healing. For example, they occurred within the first twenty-four hours when large amounts of catgut were placed in the subcutaneous fat and when the skin edges were improperly approximated and both technical faults are notorious for producing untoward healing.

Cracking of the cellophane happened once in the dressing of seventy clean wounds—hernioplasties, abdominal incisions, and wounds on the

extremities dressed with the material of the proper thickness. In this instance it occurred on the fourth day after an appendectomy in a young boy 6 years of age. The wound healed per primam, however, in spite of this accident. No other difficulties were encountered with other children. However, before the No. 600 grade was used, cracking occurred too frequently in a small series of wounds dressed with thin wrapping cellophane. Obviously, therefore, just any sheet of cellophane cannot be used. With the thin variety, it was noted that the rectangle should not be cut excessively large, for large sheets cracked more readily than smaller ones, and that crinkling caused cracking. We advise that the material be autoclaved, for sterilizing by antiseptics or by boiling causes crinkling. Assurance may be given that if the No. 600 grade cellophane cracks, the break will occur at such a time that the wound will not become infected. Sheets of this thickness have been left on the abdomen as long as ten days without cracking. Moreover, a break will seldom occur before the fourth or fifth day of healing, and, if it does, Du Mortier² has shown that after this interval there is very little possibility of infecting the wound by external contamination. In fact, none of the wounds dressed with the thin cellophane which cracked on the third and fourth days developed an infection, nor have we encountered an infection or stitch abscess which properly could be attributed to the use of cellophane. We believe it is in every way an economical and satisfactory dressing for the clean wound.

For some time Hazen, of Washington, D. C., has covered wet dressings used on ambulatory patients with cellophane, fastened by adhesive borders to prevent soiling. They stay wet for a long period of time and cellophane is less expensive than oiled silk.

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A NEW COLOSTOMY SPUR-CRUSHING CLAMP*

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(From the Surgical Service of the Mt. Sinai Hospital)

THE recent more extended use of modifications of the original Mikuliez operation for carcinoma of the colon has increased the need for an efficient spur-crushing clamp. As far as I am able to determine from conversations with other surgeons doing a large amount of colonic surgery, the crushing of a colostomy spur has heretofore been attended by considerable inconvenience both to patient and surgeon. While there are many such clamps on the market to-day, only one has given some degree of satisfaction. I refer to the clamp devised by Stetten. But even this instrument has not been uniformly successful in our hands. Among the difficulties that have

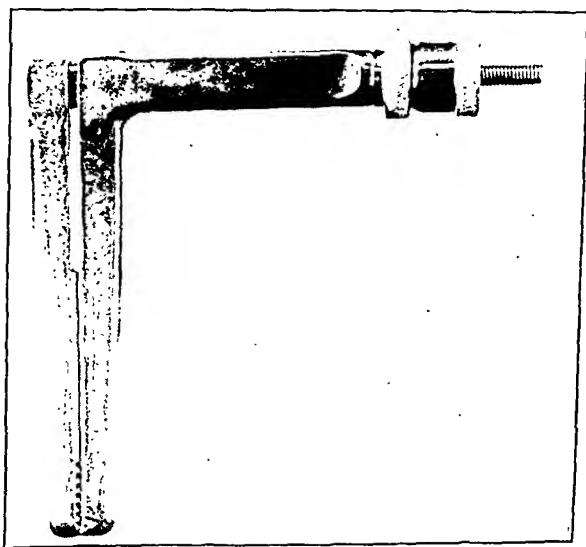


Fig. 1.—Photograph of the clamp with the blades closed.

been encountered may be mentioned: (1) slipping of the clamp; (2) the unusually long time required for complete crushing of the spur; (3) projection of the clamp beyond the surface of the skin, necessitating, in most instances, confinement to bed; and (4) the unusually wide blades of the clamp which make application of the instrument difficult in cases presenting small colostomy openings.

After considerable experimentation, the clamp pictured in the accompanying illustrations was constructed. It will be noted that the

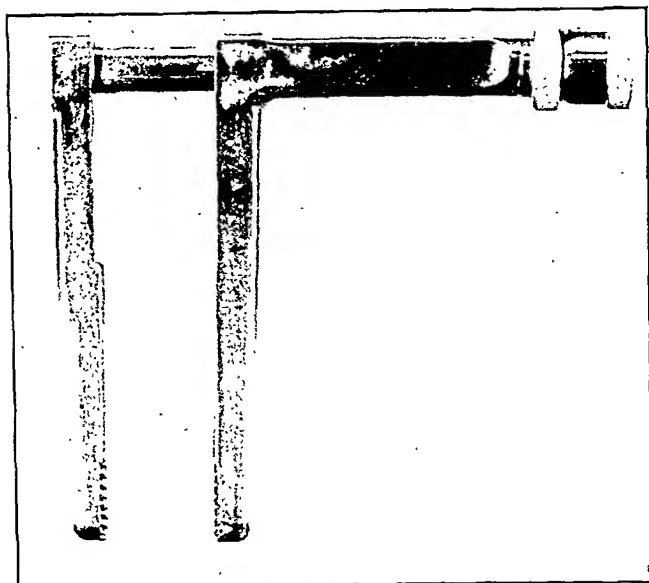


Fig. 2.—Clamp with blades opened. The instrument can be taken apart completely. It is important to cleanse and oil the smaller horizontal arm, in order to prevent rusting of the telescoping portion of the clamp.

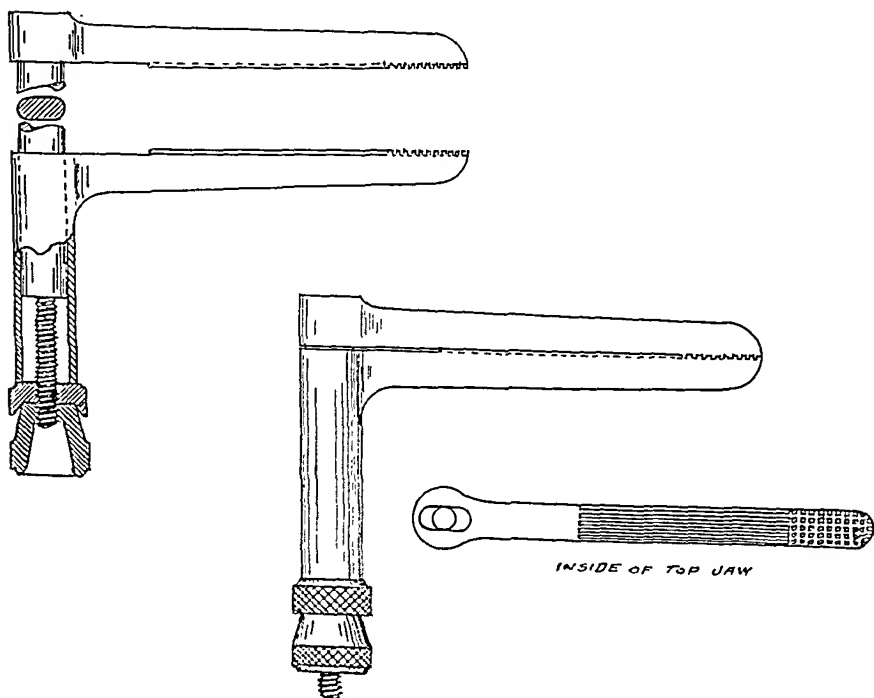


Fig. 3.—Diagrammatic representation of the clamp showing the finer details of construction.

instrument is right angled. Because of this, the distribution of the force of compression of the crushing blades is greatly increased and, at the same time, separation of the blades with slipping of the clamp cannot take place. Because the instrument is right angled, it does not project too far from the skin surface, thus allowing the patient to be ambulatory. The alternate grooves and projections on the visceral surface of each blade fit accurately into similar configurations on the opposite blade. This prevents slipping of the clamp. To accommodate patients with thin abdominal walls, I have had a smaller clamp constructed with shorter vertical blades. The efficiency of the clamp has not been impaired thereby.

Sufficient use of the clamp has been made to date to warrant recording our experiences with it. In each instance in which the clamp was used, the spur was crushed after a single application in a surprisingly short time and with little discomfort to the patient. The shortest time was 40 hours and the longest 78 hours. It must be emphasized that the turnscraws should be tightened every twelve hours in order to obtain maximum effect. In no case did the clamp slip off the spur, once it was applied.

*This clamp was constructed by B. Dubi, 555 Glenmore Ave., Brooklyn, N. Y., and may be obtained from the Kny-Scheerer Corporation of New York.

A CLAMP AND SPUR CRUSHER FOR OBSTRUCTIVE COLONIC RESECTION*

ARTHUR S. W. TOUROFF, B.S., M.D., NEW YORK, N. Y.

FROM time to time, surgeons have expressed dissatisfaction with the intestinal clamps and spur crushers commonly employed in performing so-called obstructive resection of the colon. The common criticisms have been that the clamps which are most effective are heavy and have rather long handles; and also that they require voluminous dressings to pad them and steady them in place upon the abdomen after operation. The objections to the spur crushers have been that they frequently slip off the spur, have insufficient crushing power, and also require large dressings to steady them. With the object of eliminating these various undesirable features, I have designed an instrument which, in actual practice, has fulfilled its purpose. The device consists of two units, a resecting clamp and a spur crusher.

The resecting clamp is of the well-known three-bladed variety, but its design differs considerably from that of conventional instruments. The central blade is stationary and is joined to the midpoints of two parallel side bars, the resulting frame being shaped like the letter H (Fig. 1). The two outside blades of the clamp are movable, and, instead of being hinged, slide back and forth upon the side bars, parallel to the stationary central blade. The ends of the movable blades are held in contact with the side bars by encircling collars. The position of each blade is maintained automatically by ratchets which engage in notches in the side bars and can be locked by small thumb screws. Transverse serrations, scored on the apposing surfaces of the blades, tend to prevent the bowel from slipping from the grasp of the clamp. With the usual type of clamp, slipping of the bowel not infrequently occurs after the latter has become thinned out as the result of pressure applied over a period of several days. This slipping is due to the fact that, once the clamp is applied, no provision exists for taking up the slack between the blades and the thinned-out bowel. In the present device a spring mechanism, incorporated in each of the movable blades, takes up slack and causes the bowel to be gripped firmly at all times.

The spur-crushing unit is a modification of an instrument devised by Dr. DeWitt Stetten, to whom acknowledgment hereby is made. It consists of a short, powerful, two-bladed clamp which is tightened by a bolt situated at its upper end (Fig. 2). Transverse serrations, scored on the back of each blade, interlock with the serrations on the blades of the

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resecting clamp already mentioned. In crushing the spur, the resecting unit is employed in conjunction with the spur-crushing clamp in order to increase the crushing force of the latter, to stabilize it, and to afford a means of fixing it to the abdomen (Fig. 3).

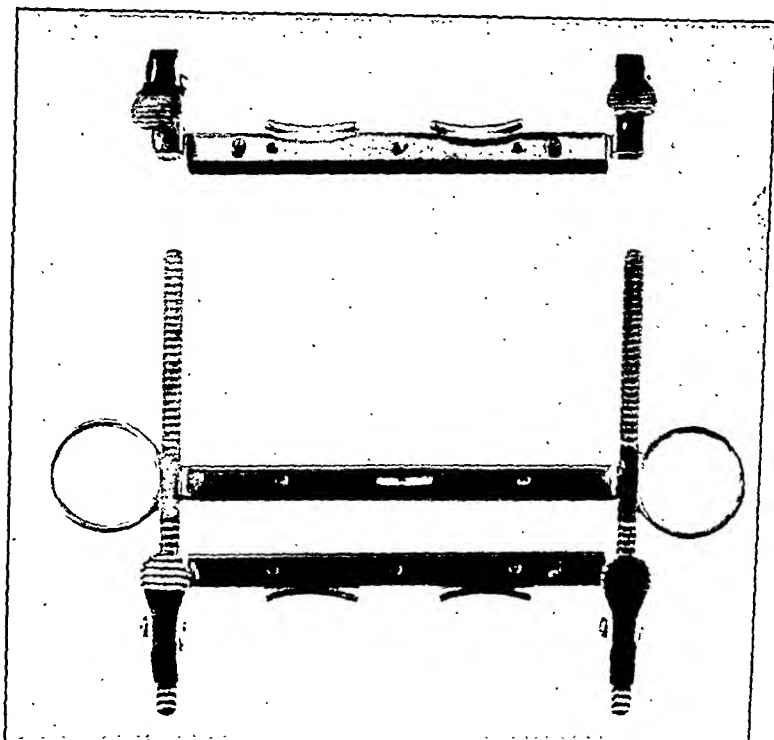


Fig. 1.—Resecting clamp, consisting of stationary central blade and two movable blades.

Note that central blade is part of an H-shaped frame. Lower half of clamp is partially closed. Note ratchets holding movable blade in place. The upper movable blade has been removed. Note grips for index fingers on frame, and thumbrests on movable blades. Spring mechanism incorporated in movable blades exerts continuous pressure on bowel when clamp is closed. (Thumbscrews which lock ratchets are not shown.)

In performing obstructive resection with these instruments, the tumor-bearing segment of bowel is isolated, an opening made in its mesentery, and the bowel freed of its blood supply in the usual manner. The two movable blades of the resecting clamp are removed, and the central blade is slipped through the opening in the mesentery beneath the isolated loop (Fig. 4, 1).^{*} The movable blades then are replaced and the two limbs of the isolated bowel clamped successively at the desired points. The surgeon does this by hooking his index fingers into the loops attached to the frame and forcing the movable blade nearest him toward the central blade with both thumbs (Fig. 4, 2). As the movable blade advances, it is prevented from slipping backward by the auto-

^{*}The author is indebted to Dr. Amiel Glass for the sketches comprising Fig. 4.

atically acting ratchets mentioned previously. After the first limb of the loop has been clamped securely, the maneuver is repeated and the opposite half of the clamp closed on the remaining limb. Usually this is best done by an assistant on the opposite side of the operating table, for he can exert stronger pressure and therefore close the remaining open half of the clamp more securely than can the surgeon from his side of the table (Fig. 4, 3). The thumbscrews on the ratchet handles next are tightened, thus securely locking the blades in position. The tumor-

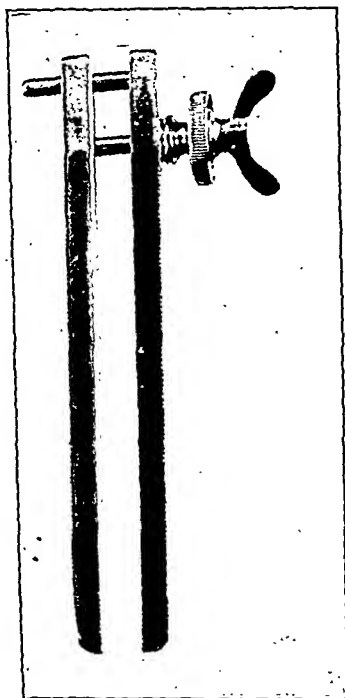


Fig. 2.—Spur crusher consists of a two-bladed clamp, closed by a bolt and locked by a wing nut. Note serrations (seen indistinctly) on the back of each blade. These interlock with serrations on the apposing surfaces of the blades of the resecting clamp. (Serrations on both instruments are best shown in Fig. 3.)

bearing loop of bowel then is resected with the cautery or carbolic knife. The choice of whether to suture the two limbs before or after resection, or not at all, rests with the surgeon. A split piece of gauze is placed beneath the instrument and the latter fixed to the abdomen by double tapes attached to Montgomery straps, one on each side of the abdomen (Fig. 4, 4). These tapes are tied to the metal loops of the frame. The exposed bowel finally is covered with vaselized gauze and a light dressing. The bowel is inspected daily and if the clamp at any time appears too loose, it may be tightened as much as desired.

After the desired number of days has elapsed, the afferent limb is released by opening the upper half of the clamp. If this limb is short and under tension and there is fear that the unclamped bowel may

retract into the abdomen, a series of sutures are passed through the edges of the open bowel and tied to the central (stationary) blade and the open movable blade (Fig. 4, 5). Since the clamp still is fastened to the abdomen and the lower (effluent) limb still is gripped securely by the lower half of the clamp, the instrument serves as a fixed point to which the open bowel may be anchored. During the period in which the instrument remains in place, while the upper limb is draining, the local area and the instrument may be kept reasonably clean by gently irrigating with a bulb syringe each time the dressings are changed.

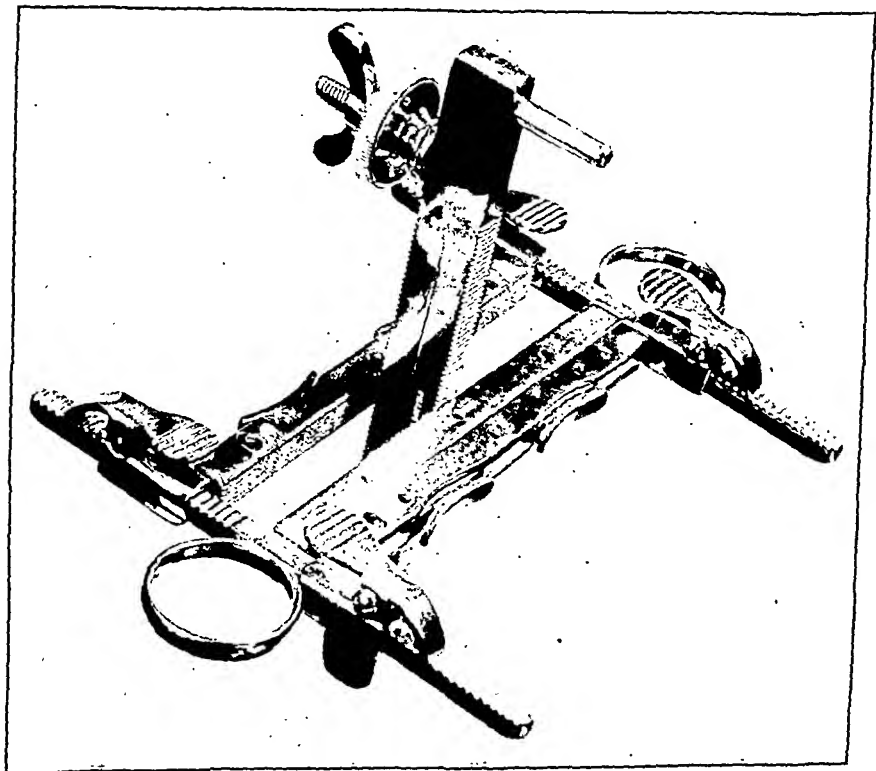


Fig. 3.—Crusher and resecting clamp assembled. After spur has been grasped by the crusher, the latter in turn is gripped between the central and one of the movable blades of the resecting clamp. Resecting clamp is applied at a point as low on the crusher as possible.

When the spur is ready to be crushed, the resecting clamp, if still in place, is removed. The spur is grasped with two Allis clamps and drawn gently out of the wound. As an assistant draws upward on the Allis clamps, the spur-crushing clamp is applied and tightened moderately. The Allis clamps are removed and traction now is made on the spur-crushing clamp by the assistant, in order to bring as much of it as possible out of the wound. The next step consists in applying the resecting clamp over the lower end of the crushing clamp in such a manner

that the latter is firmly compressed between the central blade and one of the movable blades of the resecting clamp (Fig. 4, 6). This is done while the assistant continues upward traction on the spur-crushing clamp, the resecting clamp being closed over the crusher at a point as low on the blades of the latter as possible. The serrations on the back of each crushing blade interlock with those on the blades of the resecting clamp, and the spur crusher thus is fixed securely. Increasingly firm, uniform pressure then is applied to the spur by alternately tightening the bolt at the upper end of the crushing clamp and slowly closing the resecting clamp which encircles the lower end of the crusher. In this manner as much crushing force as is desired can be applied to the spur. By exerting this additional direct pressure upon the lower ends of the

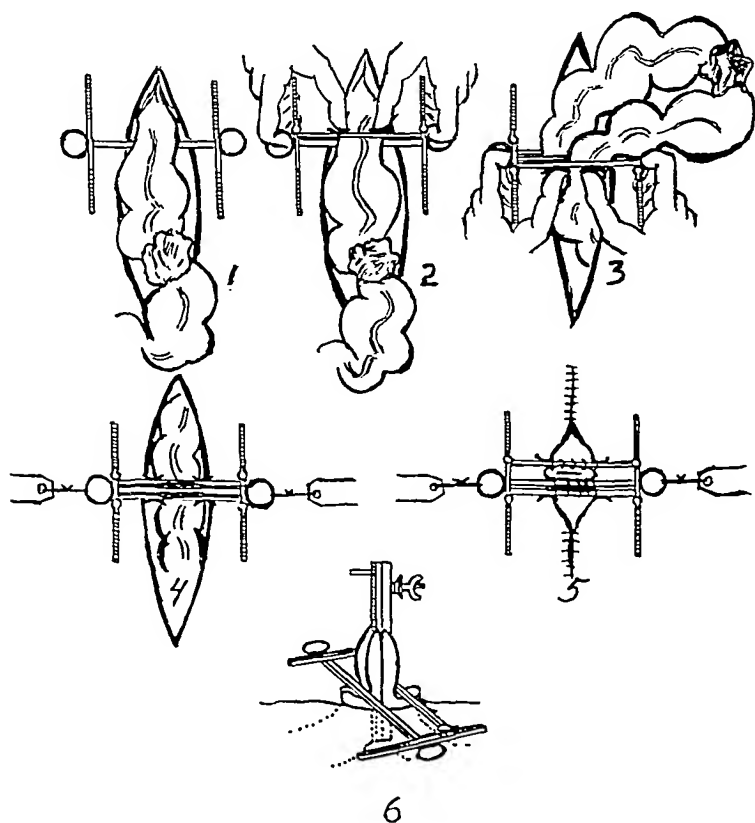


Fig. 4.—1, Tumor-bearing loop of bowel mobilized. Central blade placed beneath isolated loop, through the opening in the mesentery. 2, Upper limb being clamped. Note direction of pressure of thumbs on upper movable blade. 3, Upper limb has been clamped. Lower limb being clamped. (Note pressure again being made with thumbs, but this time from opposite direction.) 4, Both limbs have been clamped and tumor-bearing loop of bowel resected. (Note instrument fixed to abdomen by tapes attached to Montgomery straps.) 5, Optional step: After upper limb is unclamped, it may be anchored into wound by suturing it to the clamp. Lower limb may be kept clamped as long as desired. 6, Spur crushing. Crusher has been applied to spur after the latter has been gently withdrawn from wound as far as possible. Resecting clamp then is applied to crusher to increase its power and permit fixation. Tapes of Montgomery straps (not shown in drawing) are attached to loops as shown in 4 and 5.

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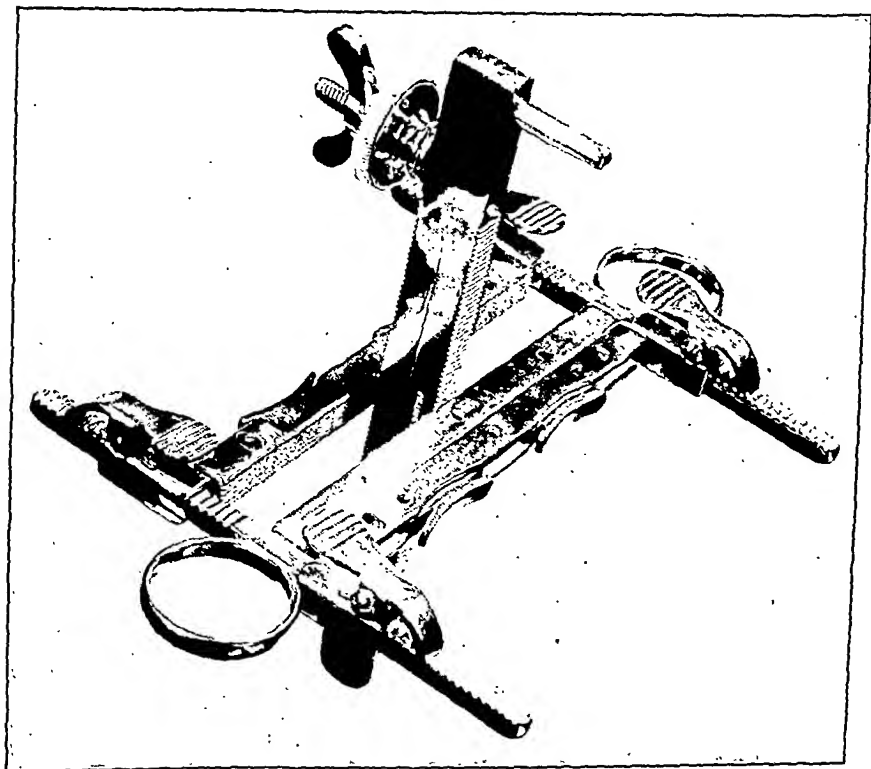


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ACUTE INTESTINAL OBSTRUCTION CAUSED BY NONABSORBABLE SUTURE MATERIAL

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(From the Pember-Nuzum Clinic)

NO DOUBT, nonabsorbable suture material as a cause of intestinal obstruction is extremely rare. Greenhill¹ collected 109 cases of foreign bodies left in the abdomen after operation and in only one, a case reported by Eckstein² in 1926, was a knotted thread of sufficient importance to be noted. In this case the patient was admitted with a fistula which had developed after appendectomy performed in another clinic a year previously. Immediately after removal of a thread, 10 to 20 cm. long, the fistula closed.

It is interesting to note in the review of the literature that Cassuto³ in 1934 reported five cases in which nonabsorbable suture material had penetrated the bladder and calculus formation had taken place on the loop of the suture material. In each case it was possible to remove the calculus along with the piece of thread. It was his suggestion that surgeons guard against placing stitches and sutures in proximity with the posterior wall of the bladder and that they use the method suggested by Pestalozza, in which a good portion of the peritoneum is dissected anteriorly above the upper strait of the uterus isolating the peritoneum without exposing the bladder. This procedure facilitates a good peritonization of the stump or a correct fixation of the uterus according to the case.

Fenkner⁴ reports a case in which one and one-half years after gastroenterostomy a second operation was done for a supposed marginal ulcer. Excision of a segment of small intestine and fragment of gastric wall was performed. A double silk suture lay about the gastrointestinal opening and in two directly opposite places protruded through the mucosa into the lumen of the small intestine in such a way that it could be moved back and forth, thus causing continuous irritation.

Fredet,⁵ discussing stenosing cancer of the small intestine and granulomas due to foreign bodies, reports a patient who had been operated upon seven and one-half years before for carcinoma; 30 cm. of small intestine had been resected. After this period of time, the patient developed indications of stenosis of the end of the small intestine; on reopening the abdomen, it was found that there was an unrecognized appendicitis of long standing. The surgeon took advantage of the opportunity to inspect the condition of the suture of the small intestine and found the intestinal continuity perfect, but for a distance of a few centimeters above and below there were small, whitish lenticular patches

crushing blades, the resecting clamp keeps the latter parallel to one another throughout their length. Thus, the tendency of the crusher to be wedged apart by the spur and to slip is reduced. After the resecting clamp has been closed as tightly as desired, the blades are locked by the thumbscrews, and the clamp is fixed to the abdomen by tapes attached to Montgomery straps as described previously. The spur crusher thus is immobilized. Finally, a split piece of gauze is placed beneath the resecting clamp and several split pads about the projecting spur crusher. Because of the firm immobilization of the crushing clamp, the patient may be gotten out of bed at once if desired. The crusher is tightened daily, by tightening the bolt at the upper end and further closing the blades of the resecting clamp at the lower end, until the spur is cut through. This usually requires four or five days.

The instrument,* which has been used with satisfactory results during the past eight months, possesses the following attributes: (1) It is of light weight and small size. (2) It has no long projecting handles. (3) Voluminous dressings are unnecessary. (4) The opened bowel may be anchored in the wound if desired. (5) Spur-crushing action is powerful and uniform. (6) The patient need not remain in bed while the spur is being crushed.

REFERENCE

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*The instrument is made by the Geo. P. Pilling & Son Co., Philadelphia, Pa.

may be provoked in sensitized organisms by catgut, which, as a sheep product, is an antigen. An allergy to catgut may be produced by catgut sutures used in a previous operation, so that reactions, which even may include intestinal occlusion, may develop in a later operation. The three cases of occlusion just mentioned in which the occlusion was due to frena arising from the site of the previous operation are quoted from the literature. The authors experimented with a desensitizing treatment of injections to be administered before undergoing operation and found it successful in overcoming this allergy and consequent formation of frena.

Urban,¹⁰ reporting a rare case of ileus in 1929, cited a patient, a domestic, 20 years of age, who was admitted to his clinic Sept. 5. She had the appearance of being extremely ill. The abdomen showed an operative scar in the middle region and another at the right side. The abdomen was not particularly distended and was only moderately sensitive to pressure. The major pains were localized in the right lumbar region and here also there seemed to be greater painfulness to pressure. The abdominal walls were tense. Early on Sept. 6, there was recurrence of severe pain. The abdomen became more and more distended and tense. When the position of the patient was changed, there was distinct dullness in the dependent portions. The rest of the abdomen was tympanitic. The hepatic dullness had practically disappeared. Deep palpation was not possible because of the great tension of the abdominal walls. Temperature was 37.2°; pulse, 96 and small.

When asked for the history, the patient reported that in April, 1927, she had undergone an operation in a gynecologic clinic because of menorrhagia. Further inquiry revealed that the operation had consisted of extirpation of the right adnexa, the left tube, and wedge excision from the left ovary.

On Nov. 29, 1927, the patient underwent another operation because of violent pain in the right lower abdomen. Numerous strands of adhesions were found in the ileocecal region and they were severed. The appendix was not found, but there was a small stump at the site of its probable origin. It would seem, therefore, that the appendix was removed at the time of the gynecologic examination.

After that operation, the patient was free from symptoms until Sept. 3, 1928. On that day, according to the report, abdominal pain and vomiting set in after the patient had partaken of pears and beer.

On September 6, operation was performed under ether and oxygen anesthesia. When the abdominal cavity was opened, there were found generous quantities of malodorous, black liquid. The loops of the intestine were very much distended and showed black discoloration. The distended snarl of intestine was lifted out and it was found that it was a matter of extensive incarceration of the ileum as far as Bauhin's valve. The mesentery belonging to the darkly discolored intestinal loop was ligated by a free loop of silk thread with a lumen which barely admitted one finger. This ligation had induced total gangrene of the corresponding portion of the ileum. The condition of the patient was so poor that it was necessary to terminate the operation quickly. For this reason, the gangrenous loops of the intestine were resected, the two stumps were drawn into the upper angle of the wound and sutured, and the rest of the abdominal cavity was closed after argochrome had been poured in. The resected portion of intestine measured 70 cm. in length.

After a stormy convalescence, the patient recovered. Urban succeeded after several months in closing the fistula by means of a submerged intestinal tube.

Urban attempts to explain how a free silk ligature could induce ileus. One explanation seems to lie in the assumption that one of the ligatures

3 to 4 mm. in diameter inserted between the peritoneum and the muscular layer. Four of these were removed and examined histologically and were found to be granulomas due to foreign bodies. Numerous plasmodia were seen containing the debris of linen thread.

Ponomarev,⁶ in his article concerning the foreign bodies left in the abdominal cavity after laparotomies, reports two cases from his own observation together with a brief review of the literature. He gives Albitzky's* series of cases which number 315 reported up to 1917; of these foreign bodies, thirteen cases were ligatures. In conclusion, the author mentions briefly several other cases which seemingly have not been reported. When the author reported the first case in a local meeting of physicians (Tomsk province), two other men reported similar cases in the open forum discussion which followed. One of these cases disclosed at autopsy a piece of omentum with ligature in the abdominal cavity of a woman who died after operation (reported by Beigel).

Doubriere,⁷ in the discussion which precedes the case histories, does not refer to occlusion due to aberrant silk sutures, but lists under causes of mechanical obstruction tampons and other such objects left in the abdominal cavity. In one case which he cites, occlusion was due to an extra catgut suture which fastened the iliac S to the bladder and produced a kink in the sigmoid. Removal of this stitch on the third day after the original operation relieved the occlusion with almost normal postoperative course. On the tenth day after the second operation, there was some urinary retention and hemorrhagic cystitis.

While this discussion deals primarily with nonabsorbable sutures, some rather interesting reports of complications following the use of absorbable sutures were found.

Fiolle and Hayem⁸ reported two cases of intestinal occlusion following appendectomy. Exploration in the first case revealed a loop of small intestine twisted and adherent to the site of the recently removed appendix. A second case had a threatened obstruction soon after removal of a ruptured appendix. However, symptoms disappeared after two weeks. Three years later occlusion occurred requiring intervention. At this time a long fibrous frenum was found extending from the stump of the appendix to the small intestine which was bent into a V at this point by traction of the frenum.

In the discussion following, Alglave also mentioned a case of occlusion following appendectomy, the adhesion being an epiploic frenum from the appendix stump to the small intestine. The conclusion in these cases was that the adhesions were the result of not burying the stump and they attached no significance to the possibility that allergy to the catgut used in tying of the stump might be a factor in causing the adhesions. However, Gilson and Gratia⁹ conducted a series of experiments on guinea pigs which proves conclusively that the Arthus phenomenon

*This article could not be located.

cent hemoglobin, 4,410,000 erythrocytes, and 8,600 leucocytes. Wassermann test was negative. A scout film showed marked distention of the small bowel in stepladder arrangement. The duodenal tube (Fig. 1) was introduced with considerable difficulty and x-ray check-up following aspiration showed less distention with arrangement of the distended loops less pronounced. The duodenal tube was apparently extending into the duodenum. Operation was deferred to allow the patient's son to arrive; her general condition was improving. On March 6, she was given 35 c.c. of 15 per cent sodium chloride intravenously. On March 8, fluoroscopic examination of the colon was ordered. During the administration of a barium enema, the x-ray

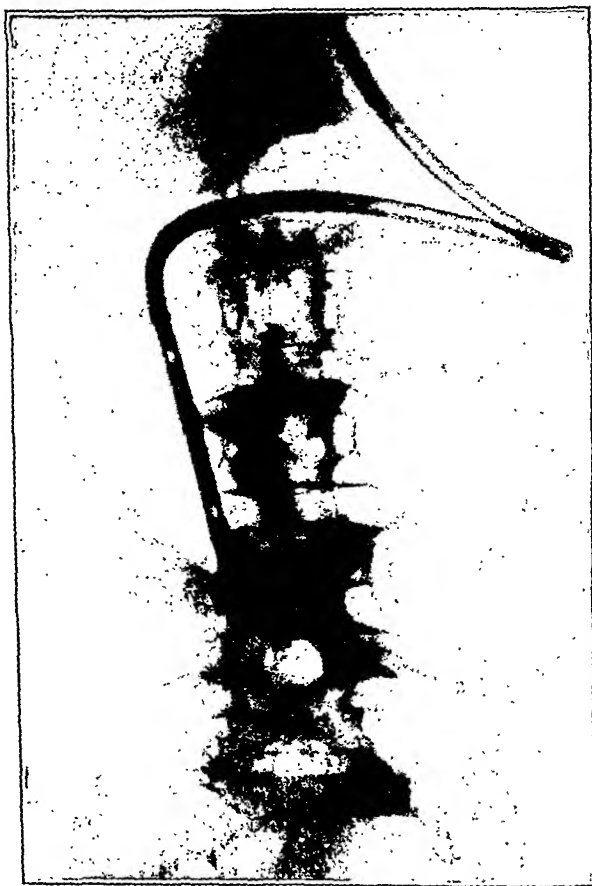


Fig. 1.—Loops of dilated small intestine with the duodenal tube in place.

(Fig. 2) showed the barium entering the colon freely until it reached the midportion of the transverse colon, at which point the barium hesitated and considerable backward pressure was established before the barium passed this point. It was impossible to milk the barium past this point by palpation for a time, and then considerable barium passed into the cecum. Films taken after fluoroscopy confirm the above findings.

Following the barium enema on March 8, at 10:05 A.M., the patient was taken into the operating room. Under local anesthesia, a small lower right oblique incision was made over the most prominent loop of intestine. On opening the peritoneum, a large amount of straw-colored fluid escaped. Exploring with one finger, an in-

applied for submersion of the stump of the tube at the time of the gynecologic operation mentioned above became partially loosened for some reason and protruded into the free abdominal cavity with the major portion of its lumen. Ligatures on the suspensory ligaments of the uterus or ligatures around a point in this region would also correspond, as to lumen, to the incarcerating ligature which was found. Now a loop of intestine seems to have become entangled in this loose silk ligature. Due to peristalsis, more and more intestinal loops were forced into this ligating thread, until the continued intestinal movements pulled the ligature from its original site of attachment. The distended intestinal loops were unable to extricate themselves from the constricting thread and complete incarceration was the result.

In conclusion, he says that, even though the most varied and peculiar causes for intestinal occlusion have been reported, the literature does not seem to contain a case similar to the above, with free silk ligature forming a stricture around a portion of the small intestine, binding it so tightly that grave ileus and complete gangrene of 70 cm. of intestine ensued.

I wish to report a similar case which recently came under my care.

A doctor's mother, Mrs. C. M., aged 71 years, married for forty-nine years, entered Mercy Hospital, March 6, 1938, with acute intestinal obstruction and chronic arthritis. Her husband was in the hospital at the same time for urinary obstruction. The patient had suffered from arthritis for a period of thirty years. She had had a hysterectomy performed twenty-four years before. She had had no loss of weight in the last year or two, though appetite had been poor for the last year. Bowels had been looser for the past year; she had dark stools only when she took cathartics; normal consistency was thinner than gravy. She complained of no excessive flatulence. She had noticed abdominal enlargement for the last two years, but had never mentioned this to anyone. The menopause was passed in 1914 when the operation was performed.

Her chief complaint was a dull pain in the abdomen. She felt quite well up to Monday, Feb. 28, when she had a normal bowel movement. Tuesday she had marked anorexia. Thursday and Friday she vomited and the vomitus was heavy brown material; several enemas were given with no result and nothing was passed per rectum since Monday. Patient's temperature was 99°; pulse, 95; respiration, 20. Her height was 5 feet, 2 inches; weight, 110 pounds.

General appearance showed senile nutritional changes comparable with age. She had a mild pallor skin; bilateral arcus senilis, pupils normal; artificial dentures; chest normal; senile emphysematous changes. Heart was normal and regular; blood pressure, 160 systolic and 80 diastolic. The abdomen was distended with the skin surface shiny; outline of distended bowel in right lower quadrant and midline. Borborygmus and tinkling were most marked in right upper quadrant. Extremities, i.e., knees, elbows, and hands, showed arthritic changes; atrophy of the muscle groups, upper arm, forearm, hands, calves, and thigh. Pelvis was negative; reflexes impaired.

Tentative diagnosis was (1) acute intestinal obstruction, probably on the basis of malignancy; (2) infectious arthritis; (3) multiple ankylosis; (4) edentulous and artificial dentures; (5) senility and arteriosclerosis. Laboratory findings at this time showed urine with a specific gravity of 1.031, trace of albumin, three plus sugar, and one plus acetone, also occasional pus cells. Blood count revealed 93 per

ent, in cleaning up and transferring things to another institution, had burned much of the material, which he considered junk, but which proved to be all the surgical records and records of the nurses' training school; this incident had caused him no end of embarrassment. He could not recollect the patient nor the procedure carried out, but he

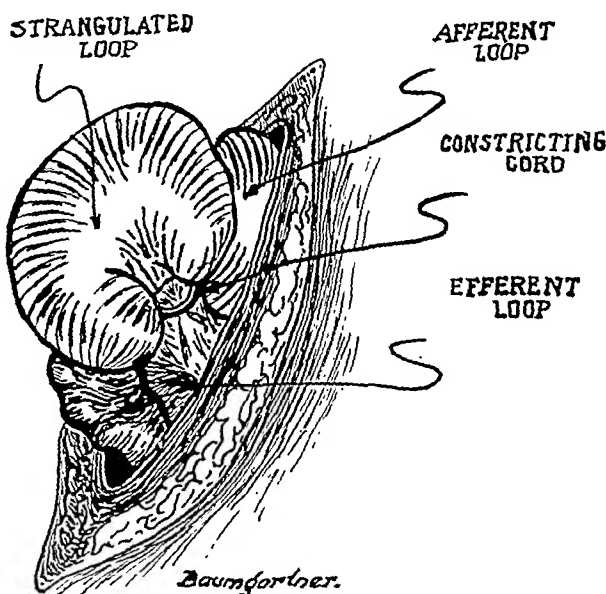


Fig. 3.—Showing loop of obstructed small intestine delivered through incision.



A.



B.

FIG. 4.—Photomicrograph. A, Enlarged 60 times; B, enlarged 120 times.

stated that he had never, in all his surgical experience, used anything but catgut and silk inside the abdomen. He raised the question as to whether this could not have been a fibrous band rather than a suture.

The material was turned over to the Pathological Section of the Wisconsin State Laboratory of Hygiene, and the report stated that the

durated loop of bowel was brought up which had a proximal dilated loop, a distal collapsed loop, and a dilated loop about 10 cm. in length which was constricted between these two loops of bowel. On first examination, this appeared like an infiltrating lesion on the mesenteric side, but further inspection showed this to be a single strand which looked like silk or linen tied around this small loop of intestine (Fig. 3).



Fig. 2.—Loops of dilated intestine with the duodenal tube and colon filled with bariun.

The strand was cut and removed, and after its removal, the bowel straightened out and started to function. A constricted area was left on either side with a lumen large enough to insert the end of the finger. With the return of peristalsis through the constricted areas and filling of the distal collapsed portion, the bowel was returned to the abdomen and the wound was closed.

The following day the patient was given 400 c.c. of citrated blood. She made a very uneventful recovery. The patient was discharged from the hospital March 18 and has been entirely well as far as her intestinal condition was concerned. She has had a rather marked improvement in her arthritis.

Following this unusual experience, I wrote to the surgeon who had operated upon her twenty-four years previously. He stated that at that time he was working in a sanitarium which he left in 1918. The institution had been sold three times since then and the last superintend-

Editorials

Intratracheal Suction in the Management of Postoperative Pulmonary Complications*

PULMONARY complications continue to be an important cause of morbidity and mortality following surgical operations involving especially the upper abdomen. As the incidence of complications has not decreased in proportion to improvements in anesthesia, a factor other than anesthesia therefore must be regarded as the causative agent in most cases in which the pulmonary lesions are not attributable to embolism or infarction. This factor is bronchial secretions.

Bronchial secretions, when present before operation, may consist merely of a small amount of mucoid material which is unnoticed by the patient and surgeon. If not present before operation, the secretions in the bronchi may occur from aspiration of pharyngeal secretions or from an increased production of mucus by the bronchial mucosal glands. If stasis of bronchial secretions is allowed postoperatively, the patient is subjected to a serious hazard, in that obstructing secretions within the tracheobronchial tree not only cause a decrease or loss of function of localized segments of the lungs but are particularly harmful in that they are infective secretions, usually containing pneumococci. Furthermore, the viscosity of the secretions makes voluntary evacuation a difficult problem for a weakened patient with a painful incision.

The diagnosis of retained secretions is aided by an appreciation of the significant symptoms and signs. The most important symptom is a relatively unproductive, wet, "rattly" cough, indicating that bronchial secretions are being incompletely evacuated. A wet cough which is productive of sputum and which is followed by a dry, unproductive cough signifies that secretions are temporarily being evacuated effectively. This sequence should warn the surgeon to provide for the evacuation of all secretions that subsequently occur. A sudden unexplained rise in temperature and in respiratory and pulse rates in the first several days after operation is also suggestive of retained secretions. The stethoscope is of greater aid than the roentgenogram in the early detection of secretions, in that rhonchi can be heard before the complications of the obstructing secretions that were causing the rhonchi can be seen with a roentgenogram. Rhonchi, rather than râles, are significant for an early diagnosis since râles are usually the late, or pneumonic, expression of secretions that were causing the rhonchi. Furthermore, rhonchi may be present when the cough is dry. Varying degrees of dullness,

*Haight, Cameron: Intratracheal Suction in the Management of Postoperative Pulmonary Complications, *Ann. Surg.* 107: 218-228, 1938.

section examined was typically that of suture material. Photomicrographs were made of the sections (Fig. 4). *A* is enlarged 60 times and *B*, 120 times.

The explanation given by Urban appears logical to me. From the history, it would seem that this suture had produced partial obstruction in this patient over quite a long period of time, and finally the bowel had worked all the way through the loop to make the obstruction complete. The fact that the bowel straightened out so completely after the ligature was cut showed that the condition encountered was of recent origin. Before operating upon this patient, we checked what appeared to be the most distal and dilated loop of the bowel that showed in the x-ray film and on physical examination. Drainage of this loop by enterostomy was contemplated, having the idea of malignancy firmly fixed in mind. The area was explored with the finger and naturally it was a great surprise to be able to deliver the lesion through such a small opening.

Apparently this happens so seldom that the reporting of this case is of very little importance except as a surgical rarity. During a recent visit to eastern clinics where such large quantities of silk are used in the abdomen, I inquired of several surgeons if they had ever seen a like complication and none could recall such a case.

It is not my purpose to discuss in any way the relative merits of nonabsorbable or absorbable suture material in the abdomen, but simply to report a very interesting and rare case of intestinal obstruction caused by a piece of nonabsorbable suture material that had been introduced into the abdomen twenty-four years previously.

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couraged to cough after each change of position. Hyperventilation with 15 per cent carbon dioxide in oxygen produces bronchial dilatation and is a valuable measure in certain cases. When unconsciousness is present, carbon dioxide should be given only when the patient is in a position which favors gravitation of secretions toward the oral pharynx where they can be aspirated. In a conscious patient carbon dioxide always should be followed by voluntary cough to determine if the tracheobronchial tree is dry and to promote evacuation of secretions should the cough be wet. Although failure of these measures may occur as a result of unconsciousness, more often it is due to the inability of a sick patient to cough effectively.

If the measures mentioned should fail to evacuate the secretions, they should be removed by intratracheal suction. The methods for providing suction are by bronchoscopy or by a catheter introduced into the trachea and bronchi. The effectiveness of the bronchoscope for the removal of postoperative bronchial secretions was first demonstrated in 1925 by Jackson and Lee and it has been of increasing usefulness in clinics in which a trained bronchoscopist is available. Bronchoscopy possesses the advantage of allowing actual visualization of the interior of the tracheobronchial tree and it enables one to be certain that all obstructing secretions have been removed. More recently the intratracheal catheter has been found to be a simple and effective means for removing secretions in the trachea and bronchi after operation. Catheter suction is a measure which is more readily available, requires less proficiency in administration, and is especially applicable when repeated aspirations at frequent intervals are required. We frequently employ catheter suction as the only means for providing intratracheal suction, but we have no hesitancy in using bronchoscopy in the occasional instance in which difficulty is encountered in introducing the catheter and in which there is uncertainty about the removal of all secretions by the catheter. Bronchoscopy, if expeditiously performed, is frequently less upsetting to a critically ill and cyanotic patient, as oxygen can be conveniently administered through the bronchoscope while the tracheobronchial tree is being cleared. In this type of case bronchoscopy may be used as the initial measure and catheter suction is then used for the repeated aspirations which are usually required in order to maintain adequate bronchial drainage until the patient is able to cough effectively.

The requirements for catheter suction are a No. 16 French soft rubber urethral catheter, a suction apparatus, and connecting tubing. A glass bronchoscopic collecting tube is customarily interposed in the system in order to estimate the amount and consistency of the secretions. The open end of the glass collecting tube is fitted with a rubber stopper with a one-quarter inch hole. As constant suction is too upsetting and provokes cyanosis, the suction is applied intermittently by occluding the hole in the stopper with the thumb. If a collecting tube is not used.

diminished breath sounds, and fremitus are usually present when the bronchial obstructive condition becomes more advanced. Tracheal râles and a wet type of breathing which is audible to the naked ear signify considerable retention of secretions. A portable roentgenogram is of value in determining the extent of parenchymal involvement. Although the roentgenogram will determine if atelectasis of one lobe or of one lung is present, the roentgenogram frequently fails in differentiating between lobular atelectasis and pneumonic infiltration. Frequently the conditions coexist, but, as treatment is designed to relieve the obstructing bronchial secretions which have been the causative agent, it is not of great therapeutic importance that a distinction be made.

The prophylaxis of nonembolic postoperative pulmonary complications is the prevention of retained secretions. The prevention of aspiration of pharyngeal secretions during and immediately following operation and the evacuation of bronchial secretions, whatever their etiology, are the most important prophylactic considerations. The factors which influence the aspiration of secretions are the type of anesthetic agent; the ease, depth, and length of anesthesia; the position of the patient during the operation; the duration of the unconscious period following operation; and the position of the patient during this period. The Trendelenburg position should be used whenever possible during the operation and until the patient regains consciousness.

The various measures which have been advocated in the prevention and treatment of nonembolic pulmonary complications are expressions of the fundamental importance of adequate bronchial drainage. As voluntary cough is the most important mechanism in the prevention of retained secretions, these measures should include, first of all, an appreciation by the patient, nurse, and surgeon of the periodic necessity of an effective cough to determine if and when secretions are present. The patient's cooperation should be obtained by explaining to him the reason for periodic coughing, even when coughing is accompanied by considerable pain. Furthermore, a painful incision may be supported by the nurse or surgeon or the patient may be shown how he can support the incision himself. When secretions are known to be present, the patient should especially be encouraged and assisted to cough fifteen minutes after each narcotic injection. Voluntary cough is more effective if the patient takes several deep breaths before each cough.

Other prophylactic and therapeutic measures include the use of the Trendelenburg position during the first twenty-four hours after operation unless this position interferes with the effectiveness of cough. In such instances the intermittent or constant elevation of the head of the bed is indicated. The frequent change of the patient from one lateral position to the other is of advantage in favoring bronchial drainage from the lower lobes, especially when the patient is in the Trendelenburg position or in a horizontal position. The patient should be en-

cessation of the constant, wearing, relatively unproductive wet cough are usually rapid and at times dramatic in their suddenness. An appreciation of the above conception of the causative mechanism of nonembolic pulmonary complications and the more frequent use of the prophylactic and therapeutic measures outlined will greatly reduce the postoperative morbidity and mortality due to respiratory complications.

—Cameron Haight, M.D.

Ann Arbor, Mich.

Correct Speech

A DOCTOR'S degree should be a mark of distinction of a learned individual. Indeed, a doctor's degree, with the possible exception of Doctor of Medicine, always indicates the acquirement of knowledge and carries with it the implication that one is able to transmit that knowledge in a creditable manner. Unfortunately, too many physicians, although they have doctor's degrees, pay little or no attention to correct speaking, because they apparently have the idea that their sole obligation to society is administration to the sick and that there is little need for transmitting their ideas in a correct manner. This statement may seem a little harsh and is undoubtedly so, because even the physician who is most careless in his speech is usually not slovenly but disregards the niceties of the English language in speaking and writing. The fault for carelessness in speech lies not with the men themselves, I believe, but in the training which they have received in medical school. I am sure that if adequate emphasis were placed on the necessity of correct speech during a student's medical school days physicians would have little difficulty in speaking correctly. Too frequently a physician in discussing an esophageal lesion will refer to "my" or "your" esophagus and in discussing the symptomatology will say "you" have dysphagia. Although the use of the personal pronoun apparently may emphasize a point, it is incorrect; and, at times it is even quite ludicrous. I recall several years ago listening to a presentation on vulvectomy in which the essayist described, by means of photographs, the operative technique. The patients illustrated were all negroes. In the final step of the operation, the essayist showed how a perivulvar cutaneous flap was sutured to the anal rectal mucosa. With the picture of a negro on the screen, the essayist proudly stated to the audience: "Now I take this cutaneous flap and suture it to my anal rectal mucosa." One wondered how he would get himself out of such a difficulty into which he had gotten so easily.

Another commonly made mistake is the incorrect use of the word "temperature." All objects have temperature, whether animate or inanimate. Whereas during life the temperature of the human body is

intermittent suction is obtained by alternately pinching and releasing the connecting tubing or by the use of a glass Y-tube in the system, the open arm of the Y being intermittently occluded with the finger. A pus trap should be employed to prevent the secretions from entering the suction apparatus.

The catheter is introduced into the nares without cocaineization of the nose, throat, or trachea and is directed posteriorly until it touches the arytenoids. The catheter is then withdrawn slightly, the patient is asked to breathe deeply, and the catheter is quickly advanced into the trachea during deep inspiration. If the patient tends to swallow the catheter, the tongue should be held by the surgeon to prevent swallowing. The patient is then asked to breathe deeply and the catheter is again advanced during inspiration. If this maneuver should be unsuccessful, the patient is asked to cough and the catheter is advanced during the inspiration following it. Should the cough reflex be absent in an unconscious patient, it can usually be stimulated by turning on the suction when the catheter is at the level of the larynx. Otherwise, the suction is not applied until the catheter has been introduced into the trachea. The tracheal secretions are aspirated before advancing the catheter into the main bronchi. As the use of the suction provokes severe coughing, the amount of suction should be regulated and the suction should be applied only for periods of several seconds each, the patient being allowed to take a few deep breaths between each application of the suction. Actually the coughing which accompanies the procedure is advantageous in that it displaces considerable bronchial secretion into the trachea where it is removed before the catheter is advanced to the level of the bronchi. The catheter is introduced into the right bronchus without difficulty; in order to introduce it into the left bronchial tree, the catheter is withdrawn into the trachea and the patient's chin is rotated far to the right side before the catheter is advanced. When the tip of the catheter has reached the level of the orifice of the lower lobe bronchus, the outer end of the catheter will be about three inches from the external nares. If the physical or roentgenographic examination shows a greater involvement on one side, the patient may be rolled on the contralateral side during aspiration of the more involved lung. Posture will thereby aid the cough in evacuating the secretions from the smaller bronchi so that they can be removed from the main bronchi. The duration of the aspiration is usually one or two minutes, the aspiration being continued until the tracheobronchial tree is dry.

The secretions obtained by intratracheal suction are invariably thick and tenacious. The bronchial obstruction in atelectasis, when observed bronchoscopically, is usually due to a diffuse accumulation of thick secretions rather than to a strictly localized mucoid plug. The general improvement of the patient following removal of obstructing bronchial secretions, the relief of dyspnea, the disappearance of cyanosis, and the

cessation of the constant, wearing, relatively unproductive wet cough are usually rapid and at times dramatic in their suddenness. An appreciation of the above conception of the causative mechanism of nonembolic pulmonary complications and the more frequent use of the prophylactic and therapeutic measures outlined will greatly reduce the postoperative morbidity and mortality due to respiratory complications.

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dependent upon intrinsic heat production and external radiation, after death the temperature of the body becomes that of the surrounding medium. Under normal conditions, the body temperature is 98.6° F. There may be deviations from this normal temperature in that it may be above or below normal. When the temperature is above normal, the individual has fever or has an elevated temperature. However, there is the apparent conception that the use of the term "temperature" for "fever" is somewhat nicer and does not denote as severe a reaction. I have the impression that many prefer to use the word "temperature" when there is only a slight pyrexia and to use the term "fever" when there is a hyperpyrexia. A frequently made mistake is the use of the word "operate" as a transitive verb. Whereas it is possible for a psychiatrist who has hypnotized a patient to operate that patient very much as one could a mechanical monkey, a surgeon operates upon an individual and does not operate him. A frequent error which is more likely to be made by nurses than physicians is the use of the word "hemorrhage" as a verb rather than as a noun, apparently because "bleeding" is considered somewhat vulgar. Whereas one cannot deny that bleeding in most instances is extremely undesirable, it can hardly be considered vulgar or common. Frequently there appears in the nurse's notes of a patient's chart, a statement that the patient "hemorrhaged" rather than that the patient bled. As hemorrhage is a noun, it is not possible for one "to hemorrhage," but one may have a hemorrhage or may bleed. Very frequently made mistakes are the uses of the names of certain diagnostic instruments as verbs. So frequently is this done that they have become almost correct by right of usage; as examples, "to cystoscope," "to proctoscope," or "to gastroscope" a patient. A cystoscope, a proctoscope, and a gastroscope are instruments of diagnosis and the respective methods of examination are cystoscopy, proctoscopy, and gastroscopy. It is possible to perform these diagnostic procedures, but one should not use the name of the instrument as a verb. Instead of saying that the patient was cystoscoped, it should be stated that a cystoscopy was done, or a cystoscopic examination was performed.

Probably one of the most frequently made mistakes is the use of the adjective "tubercular" for infections produced by the tubercle bacillus. "Tubercular" denotes morphology and is descriptive of lesions which are nodular and its use should not be limited to lesions produced by the tubercle bacillus. Whereas an infection produced by the tubercle bacillus is a tubercular one in that tubercles or nodules are formed, it is equally as true that other granulomatous lesions, such as actinomycosis or leprosy, are tubercular infections. If one wants to designate an infection as being caused by the tubercle bacillus, one should use the adjective referring only to such a lesion, calling it a tuberculous one. Apparently the adjective "tubercular" is thought to denote a less severe infection than a tuberculous one. Whereas a tubercular infection is one in which

the lesion is nodular, the term referring to the morphology of the condition, a tuberculous infection is one which is produced by tubercle bacillus.

Whereas these errors in speech may seem of little consequence and of little importance during the daily work of a busy practitioner, they represent a failure to pay attention to details which frequently is of so much importance to a physician. It is only by being meticulous in details that we, as physicians, will be able to do our best work. In addition to this, it should be the obligation of a physician to uphold the dignity of the profession not only by practicing medicine in the best way he can, but also by being worthy of his doctorate in every sense of the word.

—*Alton Ochsner.*

Erratum

In the article by Emanuel B. Kaplan entitled "Pathology and Operative Correction of Finger Deformities Due to Injuries and Contractures of the Extensor Digitorum Tendon," appearing in the July issue of the JOURNAL, in Fig. 1 on page 37 under the caption "insertions of inteross." within the illustration, the lower longer line, instead of pointing to the insertion of the interosseous on the other side, incorrectly points to the insertion of the extensor tendon at the base of the proximal phalanx.

dependent upon intrinsic heat production and external radiation, after death the temperature of the body becomes that of the surrounding medium. Under normal conditions, the body temperature is 98.6° F. There may be deviations from this normal temperature in that it may be above or below normal. When the temperature is above normal, the individual has fever or has an elevated temperature. However, there is the apparent conception that the use of the term "temperature" for "fever" is somewhat nicer and does not denote as severe a reaction. I have the impression that many prefer to use the word "temperature" when there is only a slight pyrexia and to use the term "fever" when there is a hyperpyrexia. A frequently made mistake is the use of the word "operate" as a transitive verb. Whereas it is possible for a psychiatrist who has hypnotized a patient to operate that patient very much as one could a mechanical monkey, a surgeon operates upon an individual and does not operate him. A frequent error which is more likely to be made by nurses than physicians is the use of the word "hemorrhage" as a verb rather than as a noun, apparently because "bleeding" is considered somewhat vulgar. Whereas one cannot deny that bleeding in most instances is extremely undesirable, it can hardly be considered vulgar or common. Frequently there appears in the nurse's notes of a patient's chart, a statement that the patient "hemorrhaged" rather than that the patient bled. As hemorrhage is a noun, it is not possible for one "to hemorrhage," but one may have a hemorrhage or may bleed. Very frequently made mistakes are the uses of the names of certain diagnostic instruments as verbs. So frequently is this done that they have become almost correct by right of usage; as examples, "to cystoscope," "to proctoscope," or "to gastroscope" a patient. A cystoscope, a proctoscope, and a gastroscope are instruments of diagnosis and the respective methods of examination are cystoscopy, proctoscopy, and gastroscopy. It is possible to perform these diagnostic procedures, but one should not use the name of the instrument as a verb. Instead of saying that the patient was cystoscoped, it should be stated that a cystoscopy was done, or a cystoscopic examination was performed.

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anatomically and physiologically, with the faucial tonsils. Peyer's patches are largest and most numerous in the ileum; in the jejunum they are few in number, and occasionally they are seen in the duodenum. They are situated in the antimesenteric part of the intestinal wall. They are most marked in young individuals, become indistinct in middle life, and sometimes disappear altogether in advanced life. They are freely supplied with blood vessels which form an abundant plexus around each follicle and give off fine branches permeating the lymphoid tissue in the interior of the follicle. This is best demonstrated under the magnifying glass and under powerful transmitted light. Lymphatic plexuses are especially abundant around these patches and empty into the mesenteric lymph nodes.

Nonspecific granulomatous lesions are commonly present in the small intestine, usually in the distal portion; in the cecum and at the ileocecal junction; and they follow fairly closely the distribution of the aggregated collections of lymphadenoid tissue. In the aforementioned collected series, this represents approximately 58 to 59 per cent of the total number of cases. In the remaining cases, the incidence of the cases follows comparatively closely the distribution of lymphadenoid tissue elsewhere in the alimentary canal especially of the solitary follicles. This seems to be a very remarkable fact.

The available knowledge regarding pathologic lesions of the intestinal lymphadenoid tissue, including the solitary and aggregated follicles, indicates an astonishingly large incidence and includes typhoid fever, various forms of bacteriemia, status lymphaticus, tuberculosis, the various blood dyscrasias, a case of agranulocytosis reported by Felsen,⁵¹ and the various forms of colitis and dysentery. The development of the lesions in typhoid fever is of great interest, especially with respect to the lesions in the various forms of colitis and dysentery and with respect to the lesions in mesenteric adenitis.

In *typhoid fever* the swelling and subsequent ulcerations in Peyer's patches and the secondary inflammatory reaction, etc., in the mesenteric glands and in the spleen are well known. Opinion differs as to whether the lesion is a surface infection with organisms that are swallowed, or whether the organisms enter the blood stream higher up and involve the Peyer's patches by the hematogenous route. In any event, however, the course of progression of the lesion from Peyer's patch to the mesenteric gland, etc., seems established.

The lesions in the lymphadenoid follicles in the various forms of *colitis* and *bacillary dysentery* have been amply alluded to in the previous parts of this communication.

2. *The Relationship of Nonspecific Granulomatous Lesions of the Alimentary Tract to the Abdominal Lymph Nodes (Mesenteric Adenitis).*—The lesions in the associated lymph nodes draining the various anatomic areas are also of interest in this discussion.

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

THE ESSENTIAL NATURE OF NONSPECIFIC GRANULOMATOUS LESIONS OF THE GASTROINTESTINAL TRACT

ABRAHAM O. WILENSKY, M.D., NEW YORK, N. Y.

(Continued from the August issue)

THE RELATIONSHIP OF NONSPECIFIC GRANULOMATOUS LESIONS OF THE ALIMENTARY TRACT TO THE ABDOMINAL LYMPHATIC SYSTEM

1. *The Relationship of Nonspecific Granuloma of the Alimentary Tract to the Solitary and Aggregated Collections of Lymphadenoid Tissue Contained Therein.*—Lymphadenoid tissue is constantly and characteristically found distributed throughout the wall of the alimentary tract in greater or lesser amount. Undifferentiated collections of this tissue are found irregularly distributed between areas in which the lymphadenoid tissue takes on an added importance because of the developmental augmentation of the tissue into definite anatomical structures.

Follicular collections of lymphoid tissue are found along the alimentary tract: (1) at the back of the mouth and nose, where there is a ring of lymphoid tissue consisting of the lingual, palatine, and pharyngeal tonsils; (2) in the lower part of the small intestine, as Peyer's patches; (3) in the cecum, as the vermiform appendix; and (4) in the large intestine as solitary follicles. Solitary follicles are also found scattered throughout the mucous and submucous layers of the small intestines, but they are most numerous in the lower part of the ileum. Aggregated collections of follicular lymphadenoid tissue are especially notable in the fauces and in the lower extent of the small intestine (ileum).

At the fauces the tonsils form parts of a band of lymphadenoid tissue which surrounds the opening into the esophagus and trachea. The anterior part of the ring is formed by the lingual tonsil on the posterior part of the tongue; the lateral portions consist of the palatine tonsils and the lymphadenoid tissue around the auditory tubes; posteriorly, the pharyngeal tonsil is situated on the posterior wall of the pharynx. In the intervals between these main masses smaller collections of lymphadenoid tissue are present.

In the small intestine the aggregated lymphadenoid collections are usually known as Peyer's patches and correspond, very markedly both

B. *Acute Suppurative Intra-Abdominal Lymphadenitis*: A small number of cases in which the glands are larger and go on to suppuration. Drainage of the resultant abscess is necessary. I am sure that some of the cases in this group go down in the records as cases of appendiceal abscess in which the appendix is thought to have sloughed out.

C. *Chronic Granulomatous Form of Mesenteric Adenitis*: Cases in which an excessive production of inflammatory or granulomatous tissue is produced, gluing together glands and adjacent loops of intestine. When exposed on the operating table, the resultant mass of tissue is large; the essential parts of the mass are not determinable; usually no help is available from bacteriologic or other laboratory methods; and the condition seems most obscure. In the postoperative period fever continues for indefinite periods; accumulations of pus break through and discharge from the abdominal wound; fecal fistulas form frequently; soon the patient becomes very anemic and transfusions of blood are necessary repeatedly; and in the unfavorable cases death occurs from the debilitating effects of the long, drawn-out illness.

In the present state of knowledge it must be assumed that all forms of adenitis of this type are secondary to a primary lesion in the territory drained by the given group of nodes. Inasmuch as the nodes in the ileocecal angle are related to the terminal ileum, the appendix, and the ascending colon, one must necessarily look for the primary lesion there. Knowledge of any kind concerning the latter is entirely wanting. It is, however, distinctly suggestive that in this part of the intestinal tract the lymphadenoid follicles are especially abundant and find their best development in Peyer's patches. The suggested connection is strongly supported by the well-known course of events in typhoid fever; i.e., ulceration of the Peyer's patches, mesenteric adenitis, etc. And the chain of events is further corroborated by similar phenomena which occur elsewhere in the body.

The situation is complicated by the fact that in many of the non-specific granulomatous lesions described in the literature extensive degrees of adenitis and periadenitis are described, and in these the wall of the bowel also becomes involved so that the whole area is fused together into one solid mass. When, in a bad case, the tissues are all glued together by inflammatory exudate and thickening, it is difficult to unravel the course of development of the total lesion. The anatomic and microscopic picture is not always conclusive. Again one must return to bacteriologic and agglutination tests if one wishes to make a decision; but, as has been indicated before, this is not always as helpful as one could wish.

One must recognize, therefore, that either of these two courses of development may occur; that the differentiation is difficult and in some cases, at least, impossible.

The lymphatic vessels draining the ileum, appendix, and cecum are especially numerous. Those draining the appendix and cecum are almost as numerous as the ileal group, since the lymphadenoid tissue in the appendix and cecum is abundant. They drain into the ileocolic group of glands which surround the ileocolic artery. Usually a single gland is situated between the layers of the mesenteriolum of the appendix.

The mesenteric lymph glands situated between the layers of the mesentery, are, according to Gray,⁷² Deaver,⁴³ and other anatomists, considerably more than 100 in number and arranged in a number of groups; one lying close to the wall of the small intestine among the terminal twigs of the superior mesenteric artery; a second, in relation to the loops and primary branches of the vessels; and a third, along the trunk of the artery.

The mesocolic glands lie between the layers of the transverse mesocolon, in relation to the transverse colon, especially with the right and left colic flexures, and are occasionally found along the trunk of the right and middle colic arteries.

The superior mesenteric glands receive afferents from the jejunum, ileum, cecum, vermiform process, and the ascending and transverse parts of the colon; their efferents pass to the preaortic glands.

The inferior mesenteric glands are distributed along the course of the large intestine distal to the splenic flexure extending all the way to the rectum. The glands drain these portions of the alimentary canal.

According to the experimental observations of Thompson, the lymphoid tissue of the alimentary tract of the rabbit is normally associated with the presence of gram-positive bacteria. A deficiency of vitamin A causes (1) the numbers of organisms in the lymphoid tissue to be markedly increased, especially in the lymphoid tissue of the vermiform appendix; and (2) a progressive atrophy, so that in the later stages when signs of xerophthalmia begin to develop, the lymphoid follicles were represented by only a thin layer of leucocytes. Readministration of vitamin A caused a regeneration of the lymphoid follicles. This work requires confirmation, but it is suggestive of a reason for the decline in the protective mechanism of the organism against infection and also for the loss of immunity against bacterial infection in vitamin A deficiency.

My experience with mesenteric adenitis has been described on several previous occasions. The experience may be classified as follows:

A. Acute Intra-Abdominal Lymphadenitis: Cases occur in which the clinical picture resembles very markedly that of an acute attack of appendicitis and in which the pathologic anatomic findings consist of moderately enlarged glands which, microscopically, show a simple hyperplasia. No gross changes are demonstrably visible in the appendix or in the neighboring coils of small or large intestine, and the entire process subsides in the operatively proved cases spontaneously.

desmoid tumors. I remember several instances of this kind. The microscopic picture did not yield any information and the Wassermann reaction was negative. While some of these may be associated with a foreign body, others furnish no adequate information regarding their etiology. Schloffer¹⁴⁰ has described somewhat similar cases which occurred after herniotomy operations.

5. *Inflammatory Masses in the Omentum.*—Similar inflammatory masses are found in the omentum and have been described by Braun.²² As a general rule, no etiologic cause can be discovered except occasionally when they are found associated with the irritation accompanying the constant passage to and from a hernial sac.

Inflammatory adhesions, thickenings of the omentum, such as are found in the neighborhood of infections or when constricted in a hernial sac, extensive fibrosis about the site of an ulcer, and these larger masses of inflammatory hyperplasias are all of similar causation and developmental process. They differ in the degree of momentum and period of activity, in the relative piling up of granulation or reparative tissue as compared to the destructive process, and continue as long as the infective or necrotic process remains unconquered. Thus, if no complication occurs, such as an obstruction of the bowels, the granuloma may grow to an easily palpable size, may include adjacent tissues in its mass, and may possess areas of softening or ulceration in contradistinction to other areas of indurated firmness. Indeed, the clinical picture resembles that of a malignant tumor. Neighboring glands are frequently enlarged, thus adding to the deception.

The inflammatory hyperplastic masses correspond to the infective granulomas first described in this country by Senn.¹⁴¹ He described a granulomatous tumor, the result of a necrosis of tissue, usually due to some mechanical constriction of blood supply to the involved tissue, followed by a low grade infection, and followed finally by a reparative process. The necrosis, low-grade infection, and reparative process go hand-in-hand, but the reparative process predominates, resulting in a piling up of granulation tissue until a tumorlike mass is formed. In other words, we have a breaking down and a building up with the latter conquering.

6. *Pelvic exudates* as a post-partum complication or accompanying inflammatory pelvic disease are well known as well as the large extent to which they can grow. The origin of the infection is in the uterus or tubes; the tubes are thickened, rigid, and the ends are closed; the granulomatous tissue spreads out from the latter into the pelvic retroperitoneal space and often extends considerably above the pelvic brim. Adhesions of neighboring, secondarily infiltrated coils of rectum, sigmoid, or small intestine add to the total mass. The mass of granulomatous tissue spreads by lymphatic extension. When spontaneous healing occurs, all of this excess granulomatous tissue completely disappears so that hardly

A COMPARISON OF NONSPECIFIC GRANULOMAS OF THE INTESTINAL TRACT WITH
OTHER SOMEWHAT SIMILAR HYPERPLASTIC INFLAMMATORY MASSES

1. *Inflammatory Swellings in the Neck Resulting From Cervical Adenitis.*—A group of inflammatory swellings in the neck situated in and about the cervical lymph glands becomes of interest at this point of our discussion. It is well known that the point of origin for cervical lymphadenitis may be (a) undemonstrable, (b) demonstrable in or about the teeth, or (c) demonstrable in the pharyngeal lymphadenoid tissue and tonsils. In any case the neck lesion may be as follows:

A. The lesion is limited to the glands with little or no periadenitis. This represents the counterpart to simple inflammatory mesenteric lymphadenitis.

B. Adenitis which goes on to suppuration.

C. The gland lesion is surrounded by extensive amounts of inflammatory exudate which oftentimes spreads into neighboring tissues and attains very large dimensions.

The similarity between the anatomic structures involved, pharyngeal and intestinal lymphadenoid tissue, tonsils and Peyer's patches; the fact that both of the areas are parts of the alimentary tract; cervical and mesenteric lymph glands; and the nature of the resultant lesions both in the neck and in the abdomen is most obvious.

In the neck, most marked examples of this type of hyperplastic, inflammatory, granulomatous swellings are the *woody* ("holz phlegmone") *phlegmons of the neck*. These are extensive areas of solid indurated granulomatous swellings, involving glands and periglandular tissues, often extending down to and below the clavicle and spreading onto the chest wall. They are accompanied by fever, prostration, and deterioration of the heart and circulation; usually they do not break down into large abscesses, although microscopic abscesses are distributed throughout the indurated tissue and may result fatally. These lesions have no evidences of syphilitic infection. They remind one very much of the extensive degrees of inflammatory granulomatous exudate which one sees in the belly in association with gland and intestinal conditions.

2. *Inflammatory bone lesions* frequently are surrounded by excessive amounts of granulomatous tissue. This becomes especially marked about the lower jaw. The new tissue is usually situated between the periosteum and the bone and in the periosteum itself.

3. *Foreign Body Granulomas.*—In the abdomen masses of hyperplastic inflammatory granulomatous tissue may surround the path of a foreign body in its attempted or completed passage from an intra-abdominal viscus to the skin. Sometimes the foreign body is not discovered.

4. *Inflammatory Masses in the Abdominal Wall Simulating Desmoid Tumors.*—Large inflammatory masses are found from time to time situated in and behind the tissues of the abdominal wall. They simulate

2. *That it is due to some neurotrophic disturbance.*—At the present writing, knowledge regarding disturbances of the vitamin content of the body is still being developed. Certainly we have no knowledge regarding any possible relationship between any such disturbance and any form of granulomatous lesion of the intestinal tract. In looking for any possible connection, it is conceivable that the initial stages of any anatomic change (spasm, hyperemia, relative anemia, etc.), functional change (anoxemia or other obtuse chemical changes), or symptomatic manifestations (diarrhea, hemorrhage, pain, etc.) might be due to disturbances in the quantity or quality of a single vitamin or group of vitamins available in the body. Nevertheless, it is difficult to believe that the late stages associated with intramural infection, abscess, fibrosis, etc., could result from this disturbance alone without the addition of other factors.

Whatever knowledge we have available at the present writing indicates a fairly close relationship between disturbances of vitamin content and neurotrophic change (hitherto obscure forms of neuritis, such as, for instance, beriberi, pellagra, etc.). So that whatever relationship there might be between any neurotrophic disturbance and a granulomatous alimentary tract lesion probably would take place by way of some vitamin disturbance and would probably be initiated by the latter. At the present state of our knowledge, both vitamin disturbance and neurotrophic changes must be considered together.

3. *That it is primarily or essentially an allergic manifestation.*—Sensitization of various body areas or organs to chemical, bacterial, or other toxins occurs as a primary manifestation or as a secondary phenomenon following definite forms of infection or toxemia. There is considerable ground for believing, especially from the way the symptomatology of the various forms of colitis (using the latter term in its broadest sense) behave, that the relatively sudden intensifications, exacerbations, and recrudescences of symptoms might be based upon an allergic mechanism and might be associated with the sensitization of the alimentary tract to the primary cause of the disease.

Taking the three preceding factors together, it is not an easy matter to formulate accurately the relationship of any one of these to each other, or to the disease under discussion. Nevertheless, while it seems that many times one or all of these factors play a part in enhancing the anatomic changes or clinical manifestations, it is difficult to believe that any of them are the direct inciting cause of nonspecific granuloma of the alimentary tract.

4. *That it is caused by secondary invasion of the wall of the alimentary canal from an extrinsic lesion (lymph nodes).*—U'pham¹⁵⁷ has suggested that an infection occurs in the ileocecal area which has but slight local effect on the mucous membrane, but a marked secondary effect on the glands in the drained area; an ileocecal lymphadenitis becomes estab-

a vestige of it remains. Nevertheless, recrudescences of the process and the exudate formation occur commonly with reproduction of the entire pathology, until the gynecologic organ or organs which initiate the lesion are removed.

One knows that many of these are due to gonorrheal infection. In the others the ordinary forms of bacteria are found. Anatomically there are some similarities between the pelvic exudate and the intra- and extramural exudate which characterizes intestinal nonspecific granulomatous lesions.

7. *Inflammatory Lesions Following Vascular Disturbances in the Wall of the Bowel.*—A typical example of this is the tubular stenosis which occasionally follows the reduction of a strangulated loop of bowel from a hernial sac. The lesion, however, has none of the characteristics of a nonspecific or other granulomatous lesion and is a pure fibrous atrophy resulting in a stenosis involving the entire length of bowel in which the circulation was compromised.

8. *Simple Penetrating Ulcer of the Intestine.*—The extraordinary amount of thickening which sometimes surrounds the site of a walled-off, simple penetration or perforation is essentially a peritoneal phenomenon and shows none of the characteristics of an intestinal lesion. The perforation itself is usually an embolic lesion.

9. *Radiation Lesions.**—Granulomatous lesions accompanied by extraordinary intensity of pain, scarring, fibrosis, and ulceration occur also after radiation therapy. The most common and best example is the form of proctitis which follows radiation therapy with radium for carcinoma of the cervix uteri. This form of granuloma, of course, has nothing in common with the form of granulomatous lesion which is the subject of this discussion.

10. *Intestinal Sarcoidosis.*—According to Longcope,¹⁰⁰ lesions resembling Corr and Boeck's³⁵ sarcoidosis have been described as occurring in the intestinal tract, particularly in the lower ileum and in the cecum, and some relationship has been suggested between this lesion and nonspecific granuloma. The pathologic lesions of sarcoidosis are most characteristic, however, and consist essentially of an epithelioid miliary tubercle which does not resemble in any way the microscopic picture of nonspecific granuloma. Whatever superficial resemblances occur result from the complete fibrosis which replaces the tubercle-like formations in the process of healing.

DISCUSSION

In discussing the etiology of nonspecific granuloma of the gastrointestinal tract, the following possibilities are present:

1. *That it is due to some vitamin deficiency.*

*The various forms of neoplasia obviously are not in any way associated with the subject under discussion.

statement of Winkelstein.¹⁶⁴ There is no other corroboration available at the present time. A personal communication from Bergen, of the Mayo Clinic, tells me that there this question was thoroughly investigated and for want of evidence discarded.

Most of Felsen's evidence is based upon bacteriologic agglutination and bacteriophage studies. According to Winkelstein,¹⁶⁴ who presents a somewhat opposing viewpoint:

"The identification of the organisms requires great care. The cultural characteristics alone are insufficient. In fact, using the cultural characteristics alone for diagnosis, one would be forced almost each day to report atypical *B. coli* obtained from various sources (gall bladder, genito-urinary tract, normal stools) as dysentery organisms. The agglutination in high titre of the organism by specific sera is absolutely essential for the diagnosis of an organism as a bacillary dysentery strain. . . .

"Agglutinins for dysentery organisms, while usually not of a very high titre, may occur in the blood of normal people.

"The mere finding of agglutinins in the blood is not diagnostic of bacillary dysentery. Gross agglutinins from closely related bacteria (*B. coli*) may also confuse the situation. Agglutinins may appear and disappear rapidly, or, may appear late, or, may not appear."

As far as the bacteriophage goes, Winkelstein points out that a weak bacteriophage for *B. coli* is commonly present; and if, for various reasons which he points out, it should become strongly lytic, a similar effect can be obtained upon closely related stock organisms of the dysentery group. So that the mere finding of a dysentery bacteriophage does not necessarily prove the dysentery bacillus origin of the infection. However, at the Mt. Sinai Hospital, "the finding of a dysentery bacteriophage in a fairly high percentage of the cases of ulcerative colitis of undetermined etiology and not in normal and miscellaneous controls, is assumed to be somewhat suggestive of the dysentery origin of the disease but for the reasons just cited, not conclusive evidence."

There is no sharp line of differentiation or demarcation clinically between the late stage colitis and the granuloma groups. Anatomically, the pathologic changes can present very similar pictures. Frequently there is great difficulty in obtaining adequate and/or reliable bacteriologic data upon which an opinion regarding the etiology of the given lesion can be based. Everyone of experience has seen the transition from one to the other type of lesion in the same case and, according to Winkelstein, this is particularly true of the group of lesions in the terminal ileum.

6. *That it is due to some combination of factors indicated in the preceding items.*

7. *That it is the end or terminal stage of some preceding lesion and that it is due to a secondary invader, or to a mixed infection with organisms which have not yet been identified; or,*

lished. Combining this with the work of Reichert and Mathes¹³¹ that irritating and sclerosing materials injected into the mesenteric and subserous lymphatic vessels produce sclerosis and thrombosis of the lymphatics, leading to a chronic lymphedema, Upham arrives at the conclusion, based upon these two hypotheses, regarding the origin of regional enteritis: that degenerative processes in the ileum or whatever portion of the intestine may be involved, follow, and that regional enteritis is the endstage, the primary stage being mesenteric lymphadenitis from upper respiratory tract infection (Pribram's hypothesis).

It seems to me that the opinion expressed by Upham,¹⁵⁷ Pribram, etc., that the same etiologic factor which causes the enlarged lymph nodes also causes the intestinal lesions simultaneously, which, so to speak, puts the cart before the horse, has in no way been proved and seems to me to be inaccurate. The more correct viewpoint in my opinion is that the intestinal lesion comes first; that the lymph nodes are secondary thereto; and that the latter have no separate etiologic basis. I think that the error has been made in the last group of mesenteric adenitis cases described in which excessive amounts of inflammatory exudate form and in which it is more than easy for confusion to occur in the interpretation of the demonstrable anatomic picture.

5. *That it is due to some specific infection such as infection by the Bargaen¹⁰ organisms, by an organism of the dysentery group, etc.*—At the Mayo Clinic, Bargaen's¹⁰ organism is found in 90 per cent of the cases; the finding is corroborated by animal reproduction of the disease; and a vaccine, a culture filtrate, and a therapeutic horse serum have been developed which are said to be helpful. The work has not been accepted in many quarters and Brown²⁴ and Paulson,¹¹⁷ of the Johns Hopkins Hospital, have been particularly outspoken in their criticism, basing their conclusions on the following items: (a) that only one-third of the cases were studied; (b) that they do not approve of the agglutination methods; (c) that Bargaen's work was not properly controlled; and (d) that the bacteriologic characteristics of the organism were not constant. In addition, Paulson was able to reproduce similar lesions in rabbits with organisms normally present in healthy individuals. It seems, therefore, that the best one can say for Bargaen's¹⁰ organism is that the work needs considerable corroboration before it can be accepted. The opinion in many circles is that Bargaen's organism is a secondary invader.

Infection by organisms of the dysentery group has assumed and continues to assume a dominating position. The entire subject seems intimately bound up with the various forms of colitis.

Felsen's⁵¹ contention that nonspecific granulomatous lesions of the intestinal wall are primarily infections by organisms of the dysentery group is a further exposition of Hurst's⁷⁹ suggestion, in which the late stage of the dysentery infection becomes a nonspecific granuloma, has found only slight corroboration in the carefully restricted and guarded

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8. *That it is the end result of more than one preceding intrinsic lesion and is caused, with or without the aid of some of the other factors mentioned by the transfer of a surface (mucous membrane) lesion, to the deep layers of the wall of the alimentary canal.*

SUMMARY AND CONCLUSIONS

The available facts reviewed in this communication indicate that hypertrophic granulomatous lesions are encountered in infections with amoebae, in infections by various strains of the dysentery group, in the group of so-called nonspecific ulcerative colitis, associated with previously existing conditions, such as diverticulitis, or as a chronic development unassociated apparently with any preceding condition. Similar lesions are found in the post-partum period or associated with inflammatory disease of the adnexa. In addition, somewhat similar lesions are found in the neck and under other conditions in the abdominal cavity unassociated with the intestinal tract, so that it seems that the granulomatous lesion is rather widespread in the body and of a diverse protein character. In any case, in the gastrointestinal tract the characteristic part of the lesion consists in a spread of a surface lesion to an intramural position in the wall of the alimentary canal. Essentially the lesion seems to be a form of chronic infection of the lymphatic apparatus of the deeper layers of the bowel wall which implicates the solitary and aggregated collections of lymphadenoid follicles, the lymphatic channels, and the associated lymph nodes in the appropriate part of the mesentery. During the development of the lesion, the original agent of infection commonly disappears and secondary infection takes place. As a consequence of this, intramural abscesses form. During the healing or attempted healing of the latter, cicatrization is accompanied by the excessive production of scar tissue; and the latter causes a hypertrophic thickening of the bowel wall with subsequent stenoses.

In view of the several different original etiologic factors or conditions, it seems difficult to ascribe this lesion to any one original cause. My own opinion inclines me to the belief that the nonspecific granulomatous lesion is a nonspecific one, not only because some original specific factor has disappeared, but because the granulomatous lesion may follow more than one somewhat similar or distinctive agents or conditions; and that the granulomatous part of the lesion represents an end result of a diversely initiated lesion of bowel infection marked by final or secondary intramural infection and subsequent evidences of an attempted overproductive but unsuccessful healing.

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appendix and peritonitis either localized or generalized becomes the important consideration. Once peritonitis has developed, conservative management is indicated because of the characteristic tendency of the peritoneum and omentum to localize the process with adhesions. Surgical intervention during this stage is undesirable because the manipulations of the surgeon result in the breaking down of these protective adhesions and the consequent dissemination of the infection.

The most common complications of appendical peritonitis are virulent infection, residual abscesses, and pylephlebitis. A succinct discussion of the incidence, clinical manifestations, diagnostic criteria, and proper management of each of these complications was then presented. Emphasis was placed upon the Nather-Ochsner extraperitoneal approach in the drainage of subphrenic abscess.

These three presentations were discussed together: **Claude F. Dixon**, Rochester, Minn., stated that he is convinced of the value of intraperitoneal vaccination, especially in surgery of the colon. He cited a series of 180 such operative cases in which intraperitoneal vaccination was performed with a total mortality of 6 per cent, as compared with a similar series in which vaccination was not done with a total mortality of 17 per cent. In studying the cellular response to intraperitoneal vaccination, he found that the peritoneal fluid count rose from 2,000 to 96,000.

Fred Collier, Ann Arbor, Mich., stated that peritoneal immunity is due to a hyperproduction of leucocytes and that the prognosis can be determined by studying the bacterial and cell counts on a smear of one drop of the peritoneal fluid. Whereas the local peritoneal reaction is important in the prognosis, of equal significance is the general condition of the patient. Every attempt should be made to combat distention, dehydration, and anoxia by appropriate therapeutic measures, and operative manipulation in the peritoneal cavity should be reduced to a minimum. Coli bacterogen should not be employed routinely in abdominal operations but is indicated in cases in which gross contamination has occurred.

J. Shelton Horsley, Richmond, Va., stated that he treats all cases of appendicitis, regardless of the stage of the process, by immediate operation. The McBurney incision is employed routinely. The operative removal of the appendix consists of ligation, severance with the cautery, and cauterization of the stump with pure phenol. In a series of 885 cases of appendicitis treated in this manner, there were 5 deaths.

W. Wayne Babcock, Philadelphia, Pa., stated that there are four important factors in the consideration of peritonitis: (1) toxic, (2) propagative, (3) diffusing, and (4) protective factors. He discussed the principle of "internal exteriorization" in the treatment of appendical abscess and presented slides illustrating the use of glass "lamp chimney drains" to which is applied constant suction.

Alton Ochsner, New Orleans, La., emphasized the necessity of differentiating appendicitis and appendical peritonitis because of the difference in prognosis and treatment. One of the most frequent and most serious complications of appendicitis is subphrenic abscess. This is shown by the fact that in a series of 3,533 collected cases of subphrenic abscess recently analyzed by Dr. Ochsner and **Michael DeBakey**, New Orleans, La. (*Internat. Abst. Surg.* 66: 426, 1938), the origin was from the appendix in 30.9 per cent. The gravity of this complication is illustrated by the fact that in a series of 3,038 collected cases the general mortality was 53.5 per cent. The site of localization of subphrenic abscess is of particular significance from the standpoint of treatment. In a series of 1,532 collected cases, the subphrenic abscess was localized on the right side in 906 (59 per cent), on the left side in 493 (27.6 per cent), on both sides in 68 (4.4 per cent), and retroperitoneally in 223 (14.5 per cent). Emphasis was placed upon the method of drainage of these abscesses. Thus, of 394 collected cases drained

Review of Recent Meetings

REVIEW OF SECTION ON GENERAL AND ABDOMINAL SURGERY, AMERICAN MEDICAL ASSOCIATION, MAY 17 TO 19, 1939, ST. LOUIS, MO.

MICHAEL DEBAKEY, M.D., NEW ORLEANS, LA.

FRED COLLIER, Henry K. Ransom, and Charles Sherrill Rife, Ann Arbor, Mich.: Further Experimental Studies on Reaction of the Peritoneum to Trauma and Infection.—The authors performed various abdominal operative procedures, such as gastroenterostomy, enterocolostomy, colostomy, and "precolostomy," on the dog in an attempt to determine experimentally whether the peritoneum can be protected against infection. *Bacillus coli* organisms were used as the infective agent and the minimum lethal dose by intraperitoneal injection was found to be "one-fourth slant." Whereas the survival time of the animals was used as one criterion for determining the degree of immunity conferred on the peritoneum by the various operative procedures, the cellular response of the peritoneum, i.e., the mobilization of polymorphonuclear leucocytes and the amount of phagocytosis, was considered a better quantitative method. The results of inoculation two weeks after an operative procedure such as colostomy showed a marked increase in the total leucocyte count of the peritoneal fluid but considerably less if the inoculation was done four weeks after the operative procedure. The authors concluded from their studies that not enough immunity was conferred on the peritoneum by such operative procedures to justify stage operations.

Bernhard Steinberg, Toledo, Ohio: Stages in Peritonitis Based on the Defense Mechanism in Relation to Treatment.—Peritonitis is a progressive condition characterized by three stages: (1) the primary stage, in which the defense mechanism is maximal; (2) the secondary stage, in which the inhibitory elements become manifest; and (3) the tertiary stage, in which irreparable damage to tissue occurs. From the prognostic as well as the therapeutic standpoint, it is important to determine the stage of the condition. In the primary stage the body defense mechanism can be enhanced by the use of bactrogen. In the secondary stage this procedure is of no value. Attempts should be made to conserve the cardiovascular system. Small transfusions (200 c.c.) are helpful. In the tertiary stage there is little that can be accomplished. The respective stages can be determined by examining microscopically a smear of the peritoneal fluid obtained at operation or by a specially devised aspirating needle. Numerous leucocytes and only three bacteria or less in a high-powered field characterize the first stage. Fewer leucocytes and four to six bacteria suggest the second stage. Leucocytes in process of disintegration and ten or more bacteria indicate the tertiary stage.

George D. Lilly, Miami, Fla.: Complications of Appendical Peritonitis.—Emphasis was placed upon the necessity of distinguishing between appendicitis and appendical peritonitis. In the former the inflammatory process is limited to the appendix and immediate surgical intervention is indicated. On the other hand, in the latter the inflammatory process has extended beyond the walls of the

sis. The authors explained the development of these complications on the basis of three factors which combine to produce a fall in blood pressure and consequent cerebral anoxia: (1) the anesthetic, (2) the operative procedure, and (3) a pre-existing cardiocirculatory dysfunction which may or may not be apparent. The prevention and treatment of these complications were discussed briefly.

Henry K. Beecher, Boston, Mass., in the discussion, agreed with the authors that cerebral anoxia is the likely cause of these complications. However, he disagreed with the concept that pre-existing vascular lesions were an important factor. He suggests that the investigations, especially as regard the microscopic studies, should be controlled better by routine autopsy material.

F. H. Lewy, Philadelphia, Pa., also discussed the presentation and directed attention to vasolability as a possible factor in the development of these complications.

Alton Ochsner and Michael DeBakey, New Orleans, La.: **Thrombophlebitis, the Role of Vasospasm in the Production of the Clinical Manifestations.**—The authors expressed the opinion that the concept that mechanical blockage of the venous and lymphatic systems is of primary significance in the production of the clinical manifestation in thrombophlebitis is inadequate. In the light of their clinical and experimental investigations, it is believed that many of the symptoms and signs are due to vasospasm in the arterial and venous systems and that the vasoconstrictor impulses originate in the thrombophlebitic segment. Numerous reported clinical observations have indicated that a localized thrombophlebitic process can initiate a marked vasospasm. The authors briefly described their clinical and experimental investigations which demonstrated the occurrence of vasospasm in the presence of thrombophlebitis. They were able to show that the vasoconstrictor impulses originate in the involved segment and are transmitted over the sympathetic nervous system. Because of the vasospasm, there result increased filtration pressure, relative anoxia of the capillary endothelium, and diminution in the flow of lymph, all of which increase the amount of perivascular fluid. Accordingly, by interrupting the vasoconstrictor impulses by procaine hydrochloride infiltration of the sympathetic ganglia, there is produced a re-establishment of the normal exchange of intravascular and perivascular fluids.

This method of therapy has been employed in fifteen cases with seventeen thrombophlebitic processes and the results presented. There was prompt and permanent relief of pain in all instances. In one-half the cases the temperature returned to normal within forty-eight hours and in the other one-half, within one week. In over one-half the cases the edema subsided in eight days and in the remaining cases, within twelve days. Sixty per cent of the cases were discharged from the hospital as cured within eight days after the institution of therapy.

In the discussion, Géza de Takats, Chicago, Ill., stated that the dramatic results obtained by the authors deserve wide attention. The concept that reflexes originate from the site of a vascular block has been demonstrated and its significance in the treatment of acute vascular occlusions realized. He referred to the investigations by himself and George K. Fenn, Chicago, Ill., which showed that vagal reflexes originate from the occluded pulmonary artery in pulmonary embolism and radiate to the heart, bronchi, and gastrointestinal tract. He cited personal observations confirming the authors' results. Thus, not infrequently the hard edema present in patients suffering from Buerger's disease and resistant to rest in bed may disappear promptly after sympathectomy. Sympathetic denervation readily relieves the hard traumatic edema of Sudeck's atrophy. Whereas sympathetic block produces greater vasodilatation, in the milder cases of throm-

transpleurally and 327 cases drained transperitoneally, the mortality rates were 36.2 per cent and 35.1 per cent respectively; whereas, of 211 cases having extra-serous drainage, the mortality was 20.8 per cent.

Walter M. Boothby, Charles W. Mayo, and W. Randolph Lovelace, II, Rochester, Minn.: *One Hundred Per Cent Oxygen: Indications for Its Use and Methods of Its Administration to Surgical Patients.*—A brief review of the indications and value of oxygen therapy was presented. Whereas the various methods previously described for the administration of oxygen in the inspired air permitted only 50 to 60 per cent concentration, the present method utilizing a specially devised mask allows 100 per cent concentration, according to the authors. It presumably has the advantages of simplicity, efficiency, and economy. The authors stated that it is of special value in shock, coronary thrombosis, pulmonary embolism, gas gangrene, intestinal distention, and for the relief of headache which follows encephalography.

Alvan L. Barach, New York, N. Y., in the discussion, stressed the value of 100 per cent oxygen therapy in peripheral circulatory collapse, pneumonia, coronary occlusion, and asthma. However, it should not be administered continuously longer than two days because of the irritation to the endothelium.

Jacob Fine, Boston, Mass., stated that the inhalation of 100 per cent oxygen from one-half to three hours usually relieves headaches which follow encephalographic procedures. He emphasized its value in distention and explained its rationale on the basis of greater elimination of nitrogen.

Loyal Davis, and John Martin, Chicago, Ill.: *Surgical Lesions in the Paratrigeminal Area.*—In the paratrigeminal area there is situated the gasserian ganglion and its divisions, the internal carotid artery, sympathetic nerve fibers, and the three cranial nerves which innervate the extraocular muscles. Pressure upon these structures by lesions which may occur in this area produces a characteristic syndrome. There are two lesions which have been encountered: aneurysm of the internal carotid artery and meningiomas of the dural envelope which encloses the gasserian ganglion. Six cases of the latter type have been operated upon. The clinical manifestations usually observed are: constant pain and patchy areas of sensory loss in the face, dilated pupil, ptosis of the upper eyelid, and partial or complete paralysis of the extraocular muscles. The differential diagnosis was discussed briefly.

Ernest Sachs, St. Louis, Mo., stated that he operated upon the first case of this type in 1915 and reported it two years later. In differentiating this condition from tic douloureux, it should be recalled that pain in the former is constant and in the latter is intermittent. Moreover in this syndrome the motor root of the fifth nerve is involved, whereas in tic douloureux it is not.

Albert Behrend and Helena E. Riggs, Philadelphia, Pa.: *Cerebral Complications Following Surgical Operations.*—The authors emphasized the frequency of such postoperative cerebral complications as prolonged coma, convulsions, disturbances of psychic function, focal cerebral symptoms, and hyperpyrexia. Among several surgical services at the Philadelphia General Hospital, these complications were observed in twenty-one patients, an incidence of 6 per cent. They occur following any type of anesthesia and are seldom associated with cerebral thrombosis, embolism, or hemorrhage. Damage to brain cells as a result of anoxia due to cardiocirculatory insufficiency is believed to be the cause of these complications. Lantern slides showing microscopic sections of the brain tissue revealed the characteristic lesion to be a parenchymatous edema and chronic interstitial fibro-

ommended simple chop amputation at or just above the knee. The anatomical fascial plane suture of the stump should be reserved for the exceptional case with no infection and an abundant blood supply.

In the discussion, Willis D. Gatch, Indianapolis, Ind., stated that the no-suture guillotine type of amputation usually below the knee was the safest procedure in the presence of fulminating infection. A cod-liver oil dressing is applied to the open wound. The safest type of closed amputation is performed with a circular incision, usually in the supracondylar region. In a series of 100 cases with diabetes, the mortality was 14 per cent and healing by primary union occurred in 93 per cent.

Henry H. Faxon, Boston, Mass.: **Major Amputations in Advanced Peripheral Arterial Obliterative Disease.**—This report was based upon an analysis of 530 cases of peripheral arterial disease admitted to the Circulatory Clinic of the Massachusetts General Hospital from 1929 to 1939. Of this number, 112 were diagnosed as Buerger's disease; 176, as arteriosclerosis; and 242, as arteriosclerosis with diabetes. There were 262 cases requiring major amputations, of which 204 were single and 58 were bilateral. General considerations in the management of these conditions were presented. The guillotine amputations were performed only in the very sick patients (10 per cent). In this group the operative mortality was 25 per cent. None of the cases of Buerger's disease died; 25 per cent of the arteriosclerotic group and 32 per cent of the cases having arteriosclerosis with diabetes died. Of the 530 cases, 40 per cent had primary closed amputations with a mortality of 9.6 per cent.

In the discussion, Géza de Takats, Chicago, Ill., directed attention to the importance of determining the site of amputation and pointed out that the histamine wheal test is of value.

Henry W. Cave, New York, N. Y.: **Chairman's Address: Chronic Intractable Ulcerative Colitis; a Surgical Problem.**—Medical management and surgical procedures less radical than the complete removal of the diseased bowel in extensive, intractable chronic ulcerative colitis have proved inadequate. Emphasis was placed upon the preoperative care of the patients. Anemia, dehydration, and vitamin deficiencies must be combated. Accordingly, repeated small blood transfusions, the daily intravenous administration of 5 per cent glucose, and the institution of vitamin therapy are valuable. Daily colonic irrigations with warm saline solution are indicated, especially prior to the second-stage operation.

Those cases requiring total colectomy should have the procedure performed in several stages. Complete diversion of the fecal stream should be done at the first stage. Moreover, it is desirable to do this sufficiently early in the course of the disease. Appendicostomy, cecostomy, and colostomy are of little or no value. The operative technique employed by the author was described and illustrated by means of lantern slides. Permanent ileostomy approximately six inches from the ileocecal valve is performed through a right McBurney incision as the first stage in those cases requiring total colectomy. At the second stage, five to eight weeks or even longer after the first stage, the small segment of terminal ileum, the ascending, transverse, descending, and upper sigmoid colon are removed through a left paramedian incision. The third stage, from two to six months later, is performed as a combined abdominoperineal resection. Subtotal colectomy may be employed in a few selected cases with proved normal sigmoid and rectum, the first consisting of end-to-side ileosigmoidostomy and the second of subtotal colectomy. This has been done in 11 cases with 1 death. In the total series of 158 cases of ulcerative colitis, 27 were operated upon with 5 (18.5 per cent) deaths.

bophlebitis papaverine in $\frac{1}{2}$ gr. doses may be of value. Reference was made to the fact that early mobilization of patients did not result in an increased percentage of embolization. With J. H. Jesser, Chicago, Ill., Dr. de Takats recently analyzed 100 cases of massive pulmonary embolism and found only 11 with manifestations of thrombophlebitis. In 9 of these the manifestations appeared after the pulmonary embolism. Emphasis was placed upon the fact that patients react with different intensity to an identical vascular accident. Whereas in some patients there may be complete disappearance of arterial pulses simulating arterial occlusion, in others vasodilatation occurs. However, this premonitory vasodilatation may give rise to a marked vasoconstriction as the thrombus becomes larger.

John R. Paine, Minneapolis, Minn., stated that he and C. J. Bellis, Minneapolis, Minn., have been studying cases of thrombophlebitis with respect to the tissue tension, the skin temperature, the venous pressure, and the venogram. The tissue tensions usually have been within normal limits, as have the skin temperatures. The venous pressure usually has been slightly elevated. The venograms are difficult of interpretation, but frequently they show definite scattered areas of spasm in the demarcated veins. Since the fall of 1938, they have treated 7 cases of acute thrombophlebitis of the deep veins of the legs and 13 chronic cases by means of intermittent venous occlusion. The cuffs have been applied to the thighs and a pressure of 70 to 80 mm. Hg. with a four-minute cycle used. Treatment for three to four hours a day has been continued for a variable period. In only 2 cases, both of an acute nature, have pain and discomfort not been relieved. In about one-half of the cases edema has been decreased. The results obtained have been due in part, they believe, to release of vasospasm. The acute cases have been treated with considerable trepidation, but no embolic accidents have occurred. The effect of this type of treatment on the pulse and temperature of the acute cases has been noteworthy.

Sedgewick, Joneston, Ohio, stated that he has employed novocain block of the sympathetics in thrombophlebitis with excellent results. As a result of the presentation, he now understands the rationale.

Frederick W. Taylor, Indianapolis, Ind.: **Arteriosclerotic Gangrene: Relation of the Amputation Stump to Morbidity and Mortality.**—The high operative mortality in arteriosclerotic gangrene with or without diabetes was emphasized. Thus, in a series of 90 major amputations the case mortality was 37.6 per cent and the amputation mortality was 32 per cent. Whereas there are other significant factors, attention was directed particularly to the relation of operative procedure and stump healing to mortality. On the basis of the present series, the author found that the usual anatomical fascial plane closure in the majority of instances (a) devitalizes the already poorly nourished stump tissues, thus predisposing to necrosis and suppuration; (b) allows inadequate drainage for infected cases; (c) results in only a small number of promptly healing stumps, 19 of 90 amputations; and (d) definitely increases the operative risk and does not shorten the average postoperative hospital stay (49.5 days as compared with 51.5 for the no-suture secondary closure method and 37.5 days for the procedure of loose skin closure only). On the basis of this analysis, the author concluded that in the great majority of arteriosclerotic gangrene amputations no consideration should be given skin flaps or stump repair and that the simple circular amputation is by far the safest procedure. In those cases in which the danger of infection exists, no attempt should be made to close the stump. If infection is but a slight hazard, the skin may be closed with a few interrupted sutures. In the extremely septic patient, often with an uncontrollable diabetes, the author rec-

carcinoma of the large bowel. The early recognition of these lesions forms one of the most significant factors in operability, which in turn influences the mortality rate. Emphasis was placed upon the value of one-stage operative procedures for growths on both the right and left sides. They stated, however, that the two-stage procedures are probably better in the poor risk cases. Attention was directed to careful technique in aseptic end-to-end anastomosis. The abdominoperineal route was usually employed, most often in one stage, in operable rectal cancers. The authors presented their statistics on operability and mortality.

In the discussion, James D. Rives, New Orleans, La., stated that the success of any operative procedure on the large bowel, in his opinion, depended upon three factors: (1) careful preoperative preparations, (2) aseptic technique with no tension on the suture line to prevent possible leakage, and (3) careful handling of the gut to prevent injury to vessels and a resulting thrombosis.

Leland S. McKittrick, Boston, Mass., stressed that in his experience he had found two-stage operations for malignancy of the large bowel were preferable, particularly in poor risk cases. He expressed his admiration for the work of Dr. Stone and Dr. McLanahan, but he felt that in his hands mortality was much less with the two-stage procedure. He stated that success in operative procedures of this type depends upon four important factors: (1) adequate blood supply at the site of the anastomosis, (2) avoidance of tension on the suture line, (3) avoidance of pressure in the anastomosed gut, and (4) routine preliminary colostomy.

Henry Ransom, Ann Arbor, Mich., stated that at Ann Arbor, at the present time, the two-stage procedure is being used routinely. He expressed the opinion that, whereas the two-stage procedure gives only a slightly increased protection against peritonitis, in the poor risk cases, because of less trauma, it is much better than a single-stage operation.

Claude F. Dixon, Rochester, Minn., stated that he preferred the two-stage operative procedure and in his hands the mortality rate was lower. He advocated the routine administration of vitamin K in these cases as a preoperative measure to increase the coagulation time. He felt that this was indicated because of a certain number of deaths due to massive hemorrhage occurring a few days after operation at the site of the anastomosis.

Frank H. Lahey, Boston, Mass., stated that at the Lahey Clinic these procedures are always performed in two stages. The operability at the Lahey Clinic is 89.9 per cent and the mortality is about 10 per cent. He stressed the difference between contact carcinoma in the peritoneum and frank metastatic lesions and stated that frequently the surgeon fails to recognize the difference in these two conditions and consequently considers the case inoperable.

Harvey B. Stone, Boston, Mass., in closing the discussion, stressed three points: (1) the importance of aseptic technique; (2) the value of the one-stage operation which he believes has its field of usefulness, particularly in the good risk cases, but for which cases must be chosen, too much emphasis possibly having been placed on the one-stage procedure; and (3) the fact that evidence of an isolated polyp in the rectum which seems to be clinically benign may be malignant. He stated that he had nine cases of this type. He advocates the local removal with a very close postoperative follow-up, and, if there is evidence of a recurrence, radical resection of the rectum is indicated.

I. S. Ravdin, Alfred Stengel, Jr., and Cecilia Riegel, Philadelphia, Pa.: Hypoproteinemia in Surgical Patients.—The authors emphasized the fact that hypo-

John D. Stewart, Boston, Mass.: Control of the Hemorrhagic Tendency in Obstructive Jaundice by the Use of Vitamin K.—The author reported the results of an investigation of the plasma prothrombin content in patients with obstructive jaundice and biliary fistula. It was observed that the plasma prothrombin level in these cases was usually low and that following operation further reduction in the plasma prothrombin may occur. Plasma prothrombin concentration less than 50 per cent normal may result in dangerous bleeding. By administering a mixture of vitamin K and bile salts, the plasma prothrombin was restored to normal and the bleeding tendency controlled. The author believes that the plasma prothrombin level depends not only upon the absorption of vitamin K from the intestines but also upon the functional capacity of the liver.

In the discussion, **H. P. Smith, Iowa City, Ia.**, stated that vitamin K should always be administered when the prothrombin level dropped below 70 per cent. He suggested that the prothrombin level may be a test of liver function. **Hugh R. Butt, Rochester, Minn.**, stated that normal prothrombin level does not necessarily mean that the patient will not bleed postoperatively. **W. Frank, Louisville, Ky.**, stated that he has observed the occurrence of hematemesis in patients when the prothrombin level reached 65 per cent.

Conrad J. Baumgartner, Los Angeles, Calif.: Congenital Lesions of the Neck.—Emphasis was placed upon the necessity of a fundamental knowledge of the embryology of the neck in a surgical consideration of congenital lesions in this area. By means of lantern slide demonstrations, the embryologic development of structures of the neck was briefly described. Thyroglossal cysts and fistulas, branchial cysts and fistulas, and cystic hygromas were considered the most important congenital lesions of the neck. Their embryologic development and clinical manifestations were described. The treatment of these lesions consists of radical excision. However, in cystic hygroma radium therapy may be employed also. The operative technique was described and illustrated.

In the discussion, **Herbert Willy Meyer, New York, N. Y.**, called attention to the masterly contribution of Wenglowksi, who, on the basis of a study of a large number of human embryos from 2 to 49 mm., propounded a sound explanation for the embryologic development of these congenital lesions.

Manuel Grodinsky, Omaha, Neb.: Ludwig's Angina, Retropharyngeal Abscess, and Other Deep Abscesses of the Head and Neck.—A description was given of the fasciae of the head and neck based upon a study of seventy-five adult cadavers and five full term fetuses. The method of study consisted of dissection, injection, and section. This description was illustrated by means of lantern slides. Emphasis was placed upon the necessity of a fundamental knowledge of the anatomy of these structures in the consideration of the surgical treatment of infections in this area. In Ludwig's angina infection may spread from the floor of the mouth to the submandibular space, the lateral pharyngeal space, the space between the visceral and alar fasciae, and the space between the alar and prevertebral fasciae. Stress was placed upon the significance of spread of infection from the space between the visceral and alar fasciae to the superior mediastinum, as well as from the space between the alar and prevertebral fasciae to the posterior mediastinum.

Fred A. Collier, Ann Arbor, Mich., and **Louis J. Birsner, St. Louis, Mo.**, discussed the presentation.

Harvey B. Stone and Samuel McLanahan, Baltimore, Md.: Surgical Aspects of Carcinoma of the Large Bowel.—The authors stressed the fact that delay in diagnosis is still one of the most important problems in the consideration of

Harold L. Foss, Danville, Pa.: Pathogenesis of Thyrotoxicosis With Crisis.—The results of a study of 90 cases of deaths due to hypothyroidism occurring in a twenty-year period were presented. Lantern slide pictures of many of these cases were shown, the majority of which illustrated the typical appearance of advanced Graves' disease. An analysis of the treatment instituted and the operative procedure employed and the protocols of these cases were made in an attempt to determine the mechanism of acute, hyperthyroid crisis. The author emphasized the fact that, whereas marked progress has been made in the management of hyperthyroidism, deaths in crises still occur in spite of the most careful preoperative preparation and graded operations. Moreover, the exact mechanism remains little understood.

George Crile, Jr., Cleveland, Ohio: Lateral Aberrant Thyroid Tumors.—A review of 14 cases of tumors arising in lateral aberrant thyroid tissue was presented. Whereas microscopically the pathologic characteristics of these tumors, which are almost always papillary, are frequently suggestive of carcinoma, clinically they are benign. The author emphasized the fact that these lateral cervical tumors, which are multiple, are primary and not metastatic lesions from the thyroid gland. In one-half the cases papillary tumors of the thyroid were present. Early surgical removal of all involved tissue is advocated. This has resulted in a cure in all of the author's cases. Roentgen therapy is considered ineffective.

Frank H. Lahey, Boston, Mass.: The Management of True Intrathoracic Goiter.—The author briefly described the clinical manifestations which may be produced by intrathoracic goiter. These are due, in the main, to interference with the venous drainage of the head and neck because of obstruction to the internal jugular veins and interference with breathing because of pressure upon the trachea. Such goiters are demonstrable by roentgenographic visualization. The technique by which large intrathoracic goiters may be removed without resection of the manubrium was described. This consists of coring out the center of the tumor by the surgeon's finger and thus reducing it in size and making it possible to deliver through the superior thoracic strait. It was necessary to remove the manubrium in only 3 of 365 cases of true intrathoracic goiters operated upon. The author emphasized the value of a rigid intratracheal catheter during operation and the use of helium to increase the amount of oxygen intake during the anesthetic.

Discussion of these three papers was opened by **Frederick A. Collier, Ann Arbor, Mich.**, who stated that thyroid crisis was often precipitated by diagnostic procedures before the patient reached the surgeon. Some cases come too late for treatment due to procrastination; in other cases the crises are precipitated by basal metabolic rate readings and by loss of sleep for several days. In this respect he stressed adequate sedation of these cases. He expressed the opinion that often the zealous physician performs too many diagnostic procedures on this type of case. The clinical appearance of the patient should be given preference over all laboratory findings. He also stated that frequently the general appearance of the patient is of greater value than the basal metabolic rate determinations in determining the optimum time for operation.

James H. Means, Boston, Mass., stressed the proper use of iodine in the preparation of toxic thyroid cases and it was his opinion that numerous crises were prevented by its proper use. He agreed with Dr. Foss that the etiology was still unknown. Oxygen and sedation were both important measures in addition to iodine. Hyperthermia occurring in these patients may be combatted by packing in ice. Another important factor which he believed should be stressed is getting the patient in proper psychologic state before surgery is undertaken.

proteinemia in patients with lesions of the upper gastrointestinal tract as well as with lesions of the biliary tract occurs more frequently than is commonly realized. As a result of hypoproteinemia, edema of sufficient degree may develop at the site of a new stoma to produce obstruction. Attention was also directed to the significance of hypoproteinemia in the failure of wound healing. The authors have overcome the hypoproteinemic states by the administration of amino-acid solutions, peptone hydrolysates, and normal and lyophile serums. The method employed was briefly described.

Robert Elman, St. Louis, Mo., in the discussion, emphasized the need of a well-balanced diet in handling gastrointestinal cases. He drew attention to the fact that often the diet administered to this type of patient is deficient in proteins.

Harold Lincoln Thompson, Los Angeles, Calif.: *The Immediate and Late Results of Surgical Treatment of Acute Perforation of Peptic Ulcer.*—Five hundred cases collected in a ten-year period from Los Angeles County were reviewed. These cases were from all of the hospitals in that location. The general mortality rate was 26.5 per cent. He stressed the fact that the mortality rate was higher than it should have been due to a number of factors not under the control of the surgeon, particularly the delay of the patient in seeking treatment. He presented one group of cases in which expectant treatment was used and in which the mortality rate was rather low for this form of therapy. Spinal anesthesia was found to be preferable to general anesthesia by a small margin in this series. Simple closure was the procedure of choice in operation.

In the discussion, Dan C. Donald, Birmingham, Ala., presented a series of cases from that city. His mortality rates were much the same as those of Dr. Thompson. He agreed with Dr. Thompson regarding the operative procedure as well as the anesthetic of choice.

J. W. Thompson, St. Louis, Mo., presented a series of cases from the City Hospital in St. Louis in which the general mortality in ruptured ulcer was 25.7 per cent.

C. B. Odom, New Orleans, La., presented a series of lantern slides prepared from a review recently made by Michael DeBakey, New Orleans, La., and himself of 211 cases admitted to Charity Hospital between the years of 1929 and 1939.

It was shown that, whereas according to this survey over a ten-year period the incidence of gastroduodenal ulceration in general has increased approximately one and one-half times, acute perforations have increased about seven times. Contrary to a prevalent belief, the incidence in the white and colored races in this series was almost equal. As has been repeatedly demonstrated, there was a preponderance of the male sex (98.1 per cent). The operation of choice is simple closure. Whereas of 200 cases in which simple closure was used, only 33 (16.5 per cent) died; of 7 cases in which the more radical procedures were employed, 3 (42.8 per cent) died. The type of anesthetic was also found to be significant in the prognosis. Thus, of 7 cases in which epidural block and of 154 cases in which spinal anesthesia were used, the mortality incidences were 0 per cent and 15.7 per cent, respectively; of 43 cases in which general anesthesia and of 5 cases in which local analgesia were employed, the respective death rates were 22.2 per cent and 60 per cent. The total operative mortality rate in the entire series was 17.3 per cent and the general mortality was 18.9 per cent. The most frequent and serious complications were generalized peritonitis and pulmonary affections. The former occurred in 26 cases with 24 (92.3 per cent) deaths and the latter in 24 cases with 17 (70.8 per cent) deaths.

and the function was good. The method has been used in a considerable number of cases with very satisfactory results. The method essentially is the subcutaneous transverse sectioning of the contracting fascia in the palm and in the fingers affected.

Symposium on Acute Hematogenous Osteomyelitis, arranged by D. E. Robertson, Toronto, Ont.—Those participating in the formal discussion were: J. W. McNeal, New York, N. Y., Champ Lyons, Boston, Mass.; I. H. Erb, Toronto, Ont.; Edwin W. Ryerson, Chicago, Ill.; J. Albert Key, St. Louis, Mo.; and John Wilson, Los Angeles, Calif. The historical phases of research study, clinical manifestations, pathology, bacteriology, and treatment were presented by the various speakers.

In summary the present status of available information on this subject may be outlined as follows:

1. The disease is primarily a bacteriemia, and secondarily, a localized lesion in bone.
2. Showers of bacteria in the blood stream usually are cleared quickly, but under certain conditions localize in bone (Lyons).
3. The bacteriemia may, and frequently does, remain in the blood stream as a septicemia.
4. Type of organism: Streptococcus in 50 per cent of children under 2 years of age; over 2 years of age, staphylococcus, 90 per cent (Key).
5. The primary focus of staphylococcus is most frequently a boil, abrasion, or superficial lesion; for streptococcus, more frequently through tonsils or related sources (Ryerson).
6. From primary focus, bacteria enter directly into the blood stream; absence of lymphangitis at the focus excludes lymphatic route of metastasis (Erb and Lyons).
7. The lesion in bone is a septic thrombophlebitis of the vessels in the metaphysis.
8. The vascular arrangement in metaphysis makes this an ideal bed for localization.
9. Septic thrombophlebitis has been produced experimentally under conditions of reduced virulence of the organism and lowered resistance of the host (McNeal).
10. The resistance in metaphysis comes from the reticuloendothelial cells and the leucocytes (Key).
11. Phagocytosis of bacteria is essential to localization of disease (McNeal).
12. Staphylococci do not produce antibodies in the host, therefore immunity does not exist (Erb).
13. Relation of trauma: Injury near metaphysis, as a wrench of knee, may lower the local resistance, and predispose to infection. Such injury may precede or follow the primary superficial infection. The time limit would not exceed the normal repair from such injury (a few weeks). After such time it may be assumed the particular injury does not relate.
14. Metastasis to other bones, common in osteomyelitis, may result from the primary skin lesion, but more frequently from septic emboli originating at the metaphyseal lesion (Erb).

Treatment—

1. In early stage, general supportive measures to combat a generalized infection.

James D. Rives, New Orleans, La., expressed the opinion that in such sub-tropical centers as New Orleans, the basal metabolic rate reading was probably lower by ten points than in colder climates. He felt that heat and humidity often played a role in precipitating crisis in cases of hyperthyroidism in New Orleans.

W. Bartlett, St. Louis, Mo., stated that the operative risk was best governed by the clinical appearance of the patient and that crises occurred more often in non-operative cases.

REPORT OF THE AMERICAN ORTHOPEDIC ASSOCIATION MEETING AT BUFFALO, N. Y., JUNE 5 TO 8, 1939

W. B. CARRELL, M.D., DALLAS, TEX.

THE Association met at the home of the President, W. W. Plummer. Later in the meeting Dr. Plummer delivered a timely and much appreciated presidential address, outlining the obligations of the Association to the progress of medical science.

The first day of the assembly was devoted to clinical presentations by Dr. Plummer and colleagues. Cases illustrating the end results after various types of operative procedures had been done were shown and freely discussed from the floor.

Of especial interest was a case of transcondylar fracture of the elbow with immediate swelling, loss of radial pulse, and nerve pressure symptoms. Reduction of the fracture and traction failed to relieve, and after three hours a large hematoma was exposed beneath the fascia, which had extended below the elbow and upward to the lower one-third of the arm. On release of the hematoma there was immediate return of the radial pulse and disappearance of numbness in the hand. The wisdom displayed in surgically releasing the pressure from the hematoma prevented Volkmann's ischemia.

The presentation of two cases of traumatic rupture of the biceps tendon at the elbow was interesting because of the rarity of such lesions and the methods employed for repair. Only a few cases, seven, have been previously reported. In both cases the tendon had been avulsed at or near the tubercle of the radius and the free tendon end was found in the elbow fossa. The indications for exploration had been sharp pain on lifting, followed by swelling and loss of function. The method of repair differed in the two cases. It was not anatomically correct in either, but the final function was excellent for all ranges of elbow motion. In one, after failure to adequately expose the radial tubercle, an incision was made in the posterior elbow region and the tendon fastened into the ulna. The muscle so attached was not expected to have supinating power. The patient, however, did have supination power to a full extent, which was attributed to adhesions between the torn fibers of the tendon on the radial tubercle with the tendon passing over it to its new position on the ulna. The other case had the tendon attached to that of the brachialis anticus deep in the elbow fossa. Function was excellent, but the supination power was approximately seventy-five per cent of full strength.

A case of Dupuytren's contracture seventeen years following simple subcutaneous division of the fascia at several points was demonstrated. The palm contained several subcutaneous fibrous masses, but the fingers extended freely

The conclusion seemed obvious that much depends on the surgeon, who must appreciate the problems of reduction and give his personal care in directing the details of traction and splinting. Good results follow many methods if fundamental principles are mastered by the surgeon. Dr. Johnson advised routine chemotherapy combined with good surgery and proper fixation in all compound injuries. Sulfanilamide is given routinely at Johns Hopkins Hospital and the incidence of gas infection has been reduced. "Remember," he said, "SSS, surgery, serum, sulfanilamide in compound wounds."

Dr. Orr discussed compound fractures and advised thorough debridement followed by the best possible reduction and the maintenance of position by plaster and pin fixation in each fragment.

Spondylolisthesis, H. H. Hitchcock, Oakland, Calif.—The author presented a thorough analysis of the lesion, and the paper should be read in detail when published. Three cases were shown with defects of the pedicles, and, following trauma, there was deformity or marked increase in the deformity. Previous reports (other authors) indicate a 5 per cent incidence of defective pedicles in cadaver specimens. In a study of 90 fetuses the author was not able to discover a single incidence. Furthermore, he was able to cause a bilateral separation at the pedicle and lamina junction in fetuses by hyperflexion traumas. He advanced the theory that such traumatic defects, and not accessory ossifying centers, were responsible for spondylolisthesis.

Compression Fractures of the Vertebrae in Diabetes, Mark H. Rogers and Howard F. Root, Boston, Mass.—Eight cases of single or multiple compression fractures of the spine were reported. The appearance of the lesions was similar to those found in senile osteoporosis, and in one a malignancy was strongly suspected. Neither phosphatase, calcium, nor phosphorous relations were changed. The common denominator for all was diabetes.

Internal Structure of the Vertebral Body of Man as Related to Health and Disease, George Wagoner, Philadelphia, Pa.—In the study of specimens the essayist correlated the roentgenograms and experimental lesions of the vertebrae. Vertebral bodies are made up of approximately 50 per cent spongiosum. This, in substance, is endothelial tissue with large sinusoidal spaces. The arteries enter through apertures visible in roentgenograms and empty without capillaries into the sinusoidal tissue. Veins return without valves direct to the vena cava. The sinusoidal tissue may be compared with a waterlogged marsh. The H-shaped formation shown in roentgenograms is the vascular system. Lesions of the cortex, unless quite large, are not visible, while very small lesions in the spongiosa show clearly in roentgenograms. This is contrary to the usual interpretations and will necessitate some revision in our analysis of films.

Ununited Fracture of the Neck of the Femur Treated by Combining the Smith-Petersen Nail and Bone Graft Without Opening the Hip Joint, W. E. Gallie and F. I. Lewis, Toronto, Ont.—The authors reported fifteen cases of nonunion, operated upon without exposure of the fracture site. Preliminary traction is applied for a few days, using twenty to forty pounds as may be necessary to pull the trochanter to satisfactory position. The operation is approached in manner of a recent fracture procedure. Through the lateral incision a Smith-Petersen nail is applied with firm impaction. Additional drill holes are then made and bone from the ilium is packed in well, for bridging over the fractured area. The nail is used for fixation and the bone graft used only for osteogenesis. More postoperative restrictions are required than in recent fractures. Plaster is not used, but sixty to ninety days' rest is advisable. Results are very good.

2. Vaccine does not stimulate antibodies or prevent secondary involvement in other bones; a mass of bacteria and pus in the thrombus is surrounded by three zones; serum does not penetrate the middle zone (Lyons).

3. Serum given early (bacteriemia or septicemia) reduced mortality rate from 70 to 29 per cent in a large group of cases (septicemia) reported by Shands and Baker at American Medical Association meeting not yet published (quoted by Key).

4. Sulfanilamide is of proved value in streptococci infections (Lyons).

5. Sulfanilamide of doubtful value in staphylococci infection. Sulfapyridine used on animals lived longer than controls (Lyons).

Operation Indications.—In this regard there was a variation of opinions as to early or late bone drainage. All agreed that the patient should be given rest, fluids, and transfusions during the early stage. Some would institute drainage immediately on localization (Key); others would delay for several days or longer, waiting for the patient's general reaction to improve (Wilson). The death rate incidence in septicemia was definitely lowered when operation was delayed (Wilson).

The net result demonstrated in the symposium analysis is that we have information regarding the source of infection, bacteriology, and pathology. Further studies should be directed to combating the disease in the generalized stage with more potent serums or some chemical formula as now available for streptococcus. Another problem to be solved is the control of metastasis. Lyons suggested the advisability of ligating the femoral vein when the infection localizes in the lower extremity.

Symposium on Fractures in the Shaft of the Femur, arranged by Philip D. Wilson, New York, N. Y.—Those participating formally were: Frank D. Dickson, Kansas City, Mo., A. B. LeMesurier, Toronto, Can., Alexander Aitken and George W. Van Gorder, Boston, Mass., John Dunlop, Pasadena, Calif., John R. Moore, Philadelphia, Pa. Allen F. Voshell and Robert W. Johnson, Jr., Baltimore, Md., William Darrach, New York, LeRoy Abbott, San Francisco, Calif., H. Winnett Orr, Lincoln, Neb.

The subject was covered thoroughly in all its aspects. The importance of emergency care was stressed by Dr. Dickson, who reviewed the lessons we learned in war service and their application to civil life. Doctors should give full support to the Red Cross in their work of educating the lay public in emergency care.

Dr. LeMesurier discussed the methods used in Toronto for fractures in children. Very young children are placed on a frame with an inverted U-loop at one end for suspension of both legs. If more traction is desired, the pelvis is strapped down. Older children are also placed on a frame with a Thomas splint fastened to the foot of the bed and skin traction made over a pulley. If the ring is uncomfortable the foot of the bed can be elevated. Dr. Aitken reported a study in 73 cases in children for growth changes following fractures. Those under 12 years of age with over-riding and shortening at the time of treatment have the greatest extent of compensating growth. Some gained 5 to 6 cm. In the series, those under 12 years of age at the time of fracture had at maturity an average 1 cm. longer leg on the affected side. Those over 12 years had 1 cm. shorter leg.

Other speakers reported results in cases treated by skeletal traction, Russell traction, Anderson ambulatory pin, fixation pin and plaster fixation, and finally the elective open operation method. The last championed by Dr. Darrach, emphasized the requirement of firm fixation of two planes, followed by suspension and light traction for early mobilization of joints.

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Other speakers reported results in cases treated by skeletal traction, Russell traction, Anderson ambulatory pin, fixation pin and plaster fixation, and finally the elective open operation method. The last championed by Dr. Darrach, emphasized the requirement of firm fixation of two planes, followed by suspension and light traction for early mobilization of joints.

Bone Tumors, Louis Kress, Buffalo, N. Y.—Dr. Kress, by invitation, gave an interesting clinic on primary bone tumors. With projectors placed behind four small screens, the roentgenograms, microphotographic slide, and after results could be viewed simultaneously. The discussion was of a general character and not adaptable to abstracting.

Orthopedic Treatment of Marie-Strumpell Arthritis, Loring T. Swaim, Boston, Mass.—Perseverance and painstaking care characterized the work of the author in his report of eighty-four cases treated in jackets from one to nine years. Deformities of flexion produce strain, not alone on spinal ligaments, but at hips and knees, and induce more extensive ossification. Protection permits better chest expansion, increases resistance, and results in better posture when the disease is quiescent. Jackets must be accurately fitted.

Epiphysitis of the Spine, John G. Kuhns and Louis Nathan, Boston, Mass.—In a group of seventy-one cases the results were reported for 25 cases. The youngest was 8½ years old. There were 47 females and 24 males. Faulty posture was present in all; trauma, in 9; multiple lesions of the extremities, in 3. The disability was a defective epiphysis, circulatory or traumatic, involving the cartilaginous plates on the surfaces of the vertebrae. Cases with early and adequate treatment had good posture, although residual changes, such as narrowing of the vertebrae and Schmorl's indentations, were evident in the late roentgenograms. The treatment consisted of the use of extension jackets and bed rest for severe cases, followed by exercises in fixation for a long period. Mild cases were treated by posture exercises alone.

A Further Study of the Head and Neck of the Femur in the Growing Child, W. E. Wolcott, Des Moines, Ia.—A study of the development of the circulation in the head and neck of the femur in infants and children up to 15 years of age was made. Opaque material was injected into the vessels of the ligamentum teres and capsular and nutrient arteries of the shaft of the femur. The following conclusions were reached: (1) In no instance could vessels in the ligamentum teres be demonstrated entering the head of the femur in infants or children under 10 years of age. (2) By injecting the nutrient arteries of the shaft as early as the eighth month of fetal life an anastomosis between this vessel and the capsular vessels was demonstrated. (3) Successful injections into the ossifying center through the capsular arteries, entering the base of the femoral neck, were made as early as 16 months of age. (4) The anastomosis between the capsular and ligamentum teres vessels apparently does not take place until the ossification of the femoral head is nearly complete. It is therefore obvious that circulation through the ligamentum teres does not contribute to the ossifying center in the growing child.

A New Approach to the Wrist Joint. Movies to illustrate Arthroplasty with Inert Intervening Material, M. N. Smith-Petersen, Boston, Mass.—The operative approach chiefly for wrist fusion includes resection of the lower end of the ulna. The removed bone is finally used for the graft. The subperiosteal exposure gives an excellent view of the wrist joint, and removal of the ulna fragment does not interfere with supination.

Blind Nailing of the T Fracture Lower End of the Humerus Involving the Joint, Oscar Miller, Charlotte, N. C.—The method is applicable only to comminuted fractures of the condyles extending into the joint in adults. None was compounded. The fracture is manipulated, and with the aid of traction, the best restoration possible is secured for the contacting joint surfaces. A Kirschner wire is placed through the medial condyle, and, while holding the lateral condyle firmly, it is likewise transfixed. Two or more additional wires at different planes are inserted and finally all are incorporated in plaster dressing. A few cases were reported, and the reduction and final function were good for this severely comminuted type of fracture.

End Results of Epiphyseal Arrest Operations, C. Howard Hatcher, Chicago, Ill.—Forty-two patients were studied, 14 starting from poliomyelitis, 12 from tuberculosis, and 9 from pyogenic infections. The youngest was 8 years of age; the oldest, 14. Technique used was the method described by Dr. Phemister. Growth expectancy was predetermined by Baldwin tables. Girls reach maturity two years earlier than boys. Children who have a tendency to be tall reach full height earlier. Preadolescent growth is most rapid. An accurate estimate of growth can be made, and 4 to 8 cm. can be secured, depending on number of epiphyses closed. The elective age for operation is 12 years.

Temperature Controlled Healing of Experimental Fractures, Kellogg Speed and Egbert Fell, Chicago, Ill.—Work was based on experiments previously reported, those of burying a rat's tail in its own abdominal cavity. The effect of heat on fracture healing was studied in a group of rats with the forearm fractured, the skin reflected, and the foreleg buried in the abdominal cavity. Controls had similar fractures and were treated in splints. Groups of 14-day and 30-day periods were compared. The results were firmer though less exuberant callus, which formed more rapidly than in the control groups.

The Pathology and Treatment of Subdeltoid Bursitis, J. E. Milgrim, New York, N. Y.—Dr. Milgrim reported 142 cases. Some deposits were small, and correct roentgenograms were necessary. Many cases had large masses, filling the subdeltoid fossa. The process is not infective, but is a diffuse degeneration change associated with deposits of calcium carbonate or lipid bodies. As long as the deposits remain the patient will have recurrence of pain and limited motion. On removal, recovery may be expected. Operative removal is never necessary. Aspiration with a hypodermic needle is quite simple. Some cases with firm deposit should be needled, and when the reaction causes softening, the deposits disappear or may be aspirated.

Spasmodic Torticollis, J. T. Rugh, Philadelphia, Pa.—Organic and functional torticollis should be differentiated. The functional type, from overstimulation of the eleventh cranial, first and second cervical, causes habitual spasm in muscles and is induced by emotional or other irritative factors. Once the pattern is established a long period of rest for the brain cells is necessary. Dr. Rugh's cases, demonstrated by illustrations, proved the efficacy of long periods of fixation. Plaster collars were worn six to twelve months without removal, and with total periods of two to three years in apparatus.

of the adrenals, and, finally, after section of the vagi. The typical slowing of the heart rate due to morphine and cyclopropane occurred after all of the above procedures except section of the vagi. Cutting these nerves abolished the cardiac slowing. Their conclusion is that ether increases the heart rate after morphine in the dog by depressing the vagal system and that cyclopropane augments the effect of morphine on the vagal system.

The abolition of cardiac irregularities observed in dogs after morphine and cyclopropane has also been studied by J. H. Baxter, Jr., and B. H. Robbins. These changes, such as bradycardia and ventricular extrasystoles, which were observed with an electrocardiograph, and a fall in blood pressure, occur commonly in dogs, and to a certain extent have also been reported in man. In man these irregularities also occur following the addition of atropine to the morphine before cyclopropane administration. In the dog these changes uniformly occurred before respiratory arrest. If, on the other hand, the dog was also given sodium amytal (2.5 mg. per kilogram of body weight) or sodium barbital, by intravenous injection before the administration of cyclopropane, the cardiac irregularities usually observed did not occur until respiratory arrest. They interpret the effects of these barbitals as being due to depression of vagal tone and a decrease in the irritability of cardiac tissue.

The question of restoring respiratory activity in animals or man depressed by overdose of the hypnotics or general anesthetics is an ever interesting and important subject. Picrotoxin is generally considered to produce the most efficacious respiratory stimulation following barbitol overdose. That this drug does not necessarily produce the best effect in overdose of other depressant substances is shown by the following reports. H. W. Werner, of the University of North Dakota, Grand Forks, has studied the effects of a number of drugs in rabbits depressed by overdoses of ethyl alcohol. Coramine, benzedrine sulfate, metrazol, and picrotoxin all increased the minimal lethal dose of alcohol about two times. However, the first three only produced a significant shortening in the duration of alcohol incoordination. Furthermore, coramine and benzedrine sulfate in rabbit alcohol intoxication both produced a greater rise in rectal temperature than did the other two drugs. Possibly this means an increased rate of metabolism of the alcohol. W. D. Draper and R. W. Whitehead, of the University of Colorado, Denver, have found in respiratory arrest in dogs produced by overdose of ether that the most satisfactory resuscitation with artificial respiration can be obtained if metrazol is administered before attempts at artificial respiration are commenced.

One afternoon was given over to a symposium on chemotherapy with the American Society of Biological Chemists, Inc. The subject of sulfanilamide and its derivatives was well discussed by a number of speakers. In addition, a number of papers on this subject were presented before the Pharmacological Society. H. J. White, of the Johns Hopkins University, Baltimore, Md., reported upon the effect of temperature on the bacteriostatic and bactericidal effects of sulfanilamide and sulfapyridine upon the beta hemolytic streptococcus in vitro. At 30° C. a concentration of sulfanilamide below 1,000 mg. per 100 c.c. was inactive. The activity of the drug increased as the temperature was raised. The most marked bactericidal action was observed at a temperature of 39° C. with a sulfanilamide concentration of 10 mg. per 100 c.c. A. P. Richardson, from the same university, reported upon cyanosis in birds and mice due to sulfanilamide. In both species cyanosis was obtained with high blood levels (15 to 118 mg. per 100 c.c. of blood), of the drug. In the mouse the chief effect was the production of sulfhemoglobin. In the bird methemoglobin appeared to be the substance produced. Furthermore, in the bird the intravenous injection of methylene blue reduced the methemoglobin by only approximately 50 per cent for a period of not

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(From the Department of Pharmacology, the University of Minnesota Medical School)

ALLAN D. BASS, from Vanderbilt University, Nashville, Tenn., reported upon an experimental comparison of certain skin-sterilizing agents. A modification of Birkhaug's method, using organisms occurring normally on rabbit's skin, was used. Following removal of the hair, the antiseptic solution was painted on the skin and allowed to dry. Among the results presented were the following data.

DRUG AND CONCENTRATION IN 70% ALCOHOL		% OF STERILE SKIN STRIPS
Mercesin	0.1%	80
Propyl mercuric chloride	0.1%	74.5
Pyridyl mercuric chloride	0.1%	62
Iodine	3.5, 7.0%	55
Merthiolate	0.1%	58
Metaphen	0.5%	55
Mercurochrome	2.0%	51
Ethyl alcohol (control)	70.0%	21-35

In general, the pattern of these results tends to follow other recent publications on this subject. The author noted further that if the antiseptic solutions were rubbed on the skin, their efficiency was increased.

M. H. Seevers and E. T. Stormont, from the University of Wisconsin, Madison, reported upon some of their experiments relative to acapnia hypotension. As is known, hyperventilation in the anesthetized dog or man produces marked arterial hypotension. In the nonanesthetized man or in the dog recovering from cyclopropane anesthesia, hyperventilation produced no arterial hypotension. Later this same dog under cyclopropane showed a blood pressure fall, due to hyperventilation, which was proportional to the depth of narcosis. If, in the anesthetized organism, gastric perfusion was conducted with 0.35 per cent HCl, hyperventilation produced no blood pressure fall. This acid perfusion also partially prevented the characteristic hyperventilation rise in arterial plasma pH. Therefore, these phenomena appear to be due to alkalosis. Their significant conclusion is that anesthesia interferes with chemical and functional readjustment to respiratory alkalosis.

It is well known that morphine administered to dogs produces a marked decrease in the heart rate and that ether subsequently administered leads to a restoration of the normal heart rate; whereas, cyclopropane either produces no change in the slow morphine pulse or else produces a further slowing. B. H. Robbins, O. G. Fitzhugh, and J. H. Baxter, Jr., of Vanderbilt University, Nashville, Tenn., have studied the various factors that may produce these heart rate changes. Using both general anesthetics after morphine administration, they have determined the effects on the heart rate, in normal dogs, in the same animals two weeks after removal of the thoracic sympathetic chains, and then after ligation and excision

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Book Reviews

A Descriptive Atlas of Radiographs. By A. P. Bertwistle, Ed. 4 Pp. 600, with 808 illustrations. St. Louis, 1939, The C. V. Mosby Company. \$15.

It is the misfortune of some books to live or be revived beyond the time of their normal usefulness. While this is perhaps pardonable in a work which is characterized by originality and painstaking research, there appears to be no valid reason for a new edition of Bertwistle. Whatever the situation in Great Britain may be, it can safely be said that no physician or medical student in this country is so unfamiliar with radiographs that a collection of miscellaneous reproductions will be of particular value to him. This is even more true when it is considered that the reproductions themselves are in many instances of dubious merit from a photographic standpoint. Despite the author's contention, there is no real correlation with clinical or pathologic findings and the lesions demonstrated are so advanced in grade as to themselves controvert his plea for early diagnosis by means of roentgenography.

Positioning in Radiography. By K. C. Clark. Pp. 450, with 1200 illustrations. St. Louis, 1939, The C. V. Mosby Company. \$28.

This is unquestionably the most complete book of its type in English. Practically every useful position and projection is illustrated by photographs clearly demonstrating the method and by exemplary reproductions of radiographs produced thereby. It is difficult to point out any flaw in the work itself which has been most carefully proofread so that few, if any, typographical errors are present. Any criticism which can be raised would be concerned with a lack of flexibility of technique, the exposures being for the most part based on an average patient with no attempt accurately to vary exposures with the actual thickness of the part to be radiographed. The "commercial plug" for Ilford products is not objectionable since that company does no business in this country and since the book is, in a sense, admittedly a house organ. Although the price of the work is high, it is justified by the quality of the paper, the clarity of the illustrations, and the actual size of the volume which is a credit to the publishers.

Gross Anatomy. By A. Brazier Howell, M.D., Johns Hopkins Hospital, Baltimore. Cloth. Pp. 403, with 56 illustrations. New York, 1939, D. Appleton-Century Co. \$6.

This is a very difficult book to evaluate. As stated by the author, it is primarily for undergraduate students and is offered as an aid to the student to acquire as much anatomical knowledge as is possible in the shortest length of time. With this objective, we feel that the author has succeeded to a creditable degree. It is well written with accurate and direct descriptions and a very readable style. The underlying principles of gross anatomy are plainly set forth and an effort is made to simplify the complicated anatomy that the student may quickly comprehend it.

over twenty-four hours. J. T. Litchfield, Jr., H. J. White, and E. K. Marshall, Jr., also from Johns Hopkins University, reported upon some very interesting experiments with beta hemolytic streptococcus infections in mice (100 to 1,000 lethal doses per mouse, intraperitoneally) treated with varying blood levels of sulfanilamide. To administer the drug, it was mixed with ground food in varying concentrations. Among the first to use this method with sulfanilamide and its derivatives were R. N. Bieter, W. P. Larson, E. M. Cranston, and Milton Levine, at the University of Minnesota, Minneapolis, who used it for studying the effects of various drugs in Type II pneumococcus infections in mice with excellent results. The advantage of this form of drug administration to mice is that there appears to occur an almost continuous absorption of the drug. This is important because of the speed with which these drugs are excreted. The Litchfield, White, and Marshall experiments can best be summarized in the following table:

% OF SULFANILAMIDE IN FOOD	NUMBER OF MICE	BLOOD LEVEL MG. %	% SURVIVAL AT 30 DAYS
0.5	46	7	93
1.0	37	14	81
2.0	45	28	65

It can be seen that a blood level of 7 mg. per cent produced a distinctly superior therapeutic effect. Survival rates that showed these same decreases with feeding increased concentrations of the drugs were reported by Bieter, Larson, Cranston and Levine for Type II pneumococcus infections in mice (4,000 to 8,000 lethal doses per mouse, subcutaneously). With 0.5 per cent sulfanilamide in the food, their survivals at thirty days were 20 per cent; and with 2 per cent, the survivals amounted to 12 per cent. With 0.5 per cent sulfapyridine in the food, 44 per cent of the mice survived; with 1 per cent in the food, 63 per cent of the mice survived; and with 2 per cent of sulfapyridine, only 20 per cent of the mice survived. No determinations of the blood levels of these drugs were conducted by these investigators. These important observations should cause all physicians to consider the question of optimum drug concentrations to use in human therapy. Furthermore, it may be possible to administer too much of these drugs to patients, either without producing distinctly good results, or with the possibility of producing a great measure of harm.

Actinomycosis. By Zachary Cope. Ballingbroke Hospital, Wordsworth Common; Late Hunterian Professor and Arris and Gale Lecturer, Royal College of Surgeons. Cloth. Ed. 1. Pp. 248, with 52 illustrations and 17 plates in color. New York, 1938, Oxford University Press. \$3.75.

The author of this text is well known to American surgeons for his monographs on acute abdominal disorders which have found wide favor in this country. The author demonstrates again in this text on actinomycosis his ability to relate in a well-ordered manner the significant high lights of the disease. The controversy over the exogenous or endogenous origin of the disease is reviewed and the author inclines to accept the latter; that is, harbored organisms from within the victim's own mouth are a likely source of the contagion.

The chief defect of the monograph would appear to lie in the author's lack of conviction as to what the important agents of the treatment are. In his anxiety for completeness or because of his failure to consider adequately wherein the virtues of a successful therapeutic agent lie, he leaves the reader somewhat in doubt as to which of the dozen therapeutic agents recommended are the most efficacious. A brief discussion of the principle upon which successful treatment is based would have strengthened this section materially. Nevertheless, the book may be recommended highly to clinicians as a useful source for authoritative information relating to any phase of the clinical problem of actinomycosis.

Physiology of the Uterus. By Samuel R. M. Reynolds. Cloth. Pp. 447, with 44 illustrations, 17 tables. New York, 1939, Paul B. Hoeber, Inc. \$7.50.

As the author himself states in the preface to this work: "Up to the present time, it was not been possible for students of physiology, and interested clinicians to find a connected and brief account of what is known of the physiology of uterine muscle." He has prepared such a statement in a very readable and logical form. He has correlated a large volume of anatomical, biochemical, physiologic, and pathologic literature in a reasoned, connected account. There are citations and numerous cross references to the 1,190 papers which constitute the bibliography. The work extends to a conservative discussion of therapy besides covering the field indicated in the title. Although the author disclaims any attempt at exhaustive coverage of the literature, one of the very great merits of the work lies in its richness in this regard. The work also has merit in its clear statement of numerous currently unsolved problems.

The volume is well executed and should serve as a most useful source work in this field of such great clinical and physiologic interest.

A Textbook of Neuro-Radiology. By Cecil P. Q. Wakeley and Alexander Orley. Pp. 336, with 229 illustrations. Baltimore, 1938, William Wood and Company. \$8.

A much-needed review of practically all of the well-established data in the field of roentgen diagnosis of the nervous system is here presented. Largely, the book is a compilation from the literature; whole chapters, such as the one on ventriculography, which is based entirely on the work of Lysholm and of David, Mahoudeau, Askenasy, and Brun, are taken from the experience of others. A well-arranged, complete bibliography adds very greatly to the value of the book. The writing is concise and clear and many facts are presented in a short space.

Of the many favorable features one should mention the nomenclature. The author has hopefully and wisely compiled *simple terms, often using the English equivalents rather than the Latin*. A permanent unchanging anatomical nomenclature is something that every doctor dreams of, but the dream will not come true. Histology has been completely omitted and neurology only briefly presented. It is very difficult for those who are wedded to the old school of anatomical teaching to accept the more modern abbreviated instruction in anatomy in which the teaching time has been reduced to 320 hours, as at Johns Hopkins University. With this limited amount of time available, the book undoubtedly satisfies an important need. We are not sure that it can supplement a dissecting guide entirely.

With the addition of more applied embryology, more frequent reference to surgical landmarks and surface anatomy, as well as a more frequent use of diagrams and illustrations, the usefulness of the book would be increased.

One who has not used the book for teaching may find in it many things to criticize. On the other hand, the author's reputation as a teacher of anatomy and his experience with the book in teaching anatomy should recommend it highly.

Del Carcinoma Primitivo Broncopulmonary. By Niceto S. Loizaga, M.D. Paper. Pp. 221, with 20 illustrations. Buenos Aires, 1938, Liberyo y, Editorial "El Ateno."

Primary carcinoma of the lung is receiving increasing attention and recently several treatises have appeared on the subject. During the last ten years at the Francisco Juvier Muniz Hospital in Buenos Aires, there have been forty-six cases of primary carcinoma of the lung, twenty-one of which were available for complete clinical and pathological studies. This 200 page monograph is based upon these observations.

Following an historical résumé of bronchogenic carcinoma, there is a brief consideration of its incidence in which the author demonstrates statistically the increasing frequency of the condition. Much of this is based upon reports in the literature. One chapter is devoted to a consideration of the etiology and pathogenesis in which attention is directed to smoking as a possible factor.

The chapters concerned with the anatomicopathologic and histopathologic characteristics of carcinoma of the lung form the most instructive parts of the book. These are excellently illustrated by photographs of gross and microscopic sections of the various types of lesions. On the basis of these studies the author offers the following classification: (A) cylindrical cell (typical and atypical) bronchial epithelioma; (B) bronchial epithelioma of epidermoid origin (Malpighian and para-Malpighian); (C) atypical bronchial epithelioma (cuboid and small cells); (D) polymorphoepitheliomas; (E) mucoid bronchial epithelioma of glandular origin; (F) alveolar carcinoma (histocytoma of Roger Pilot). The clinical manifestations, roentgenographic characteristics, and other diagnostic laboratory procedures are briefly considered. The book ends with résumés of twenty-eight cases.

The value of this monograph lies in the discussion of the pathologic characteristics of primary lung malignancies. The extensive bibliography is marred by a poor representation of the English and American authors. Moreover, in view of the recent advances in the surgical approach to this problem, a small paragraph devoted to this phase of the subject is obviously inadequate.

SURGERY

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Original Communications

THE SURGICAL TREATMENT OF ACUTE CHOLECYSTITIS AND COMMON DUCT OBSTRUCTION

PROFESSOR DR. HANS FINSTERER, VIENNA, GERMANY

FIFTEEN years ago Enderlen and Hotz, from collective statistics of 12,000 cases of gall-bladder operations, advised the earliest possible operation in young patients in order to improve the operative results. At that time, it was the general practice not to operate during the acute attack, but to wait until the acute symptoms had subsided before performing the radical operation. It is remarkable that not only internists but also excellent surgeons, e.g., Haberer, even now follow this rule and advise operation only when symptoms of acute pancreatitis or peritonitis develop. This point of view was founded by Metzler, a pupil of Haberer's, because the mortality of the operation during the acute attack in elderly patients amounted to 44 per cent as compared with 8 per cent during the interval between attacks. It is true that, if, with this conservative point of view, the operation finally becomes absolutely necessary during the acute attack, the mortality increases more and more, and therefore the fear of operation during the acute attack on the part of the surgeon is increased. I intend to prove that one may break this vicious circle by early operation during the acute attack.

The opponents of operation during the acute attack with fever pretend that the operation is too dangerous and its mortality too high; therefore, it may not be recommended as the operation of choice. The mortality depends upon many factors; the operation itself is the least important. The condition of the gall bladder and the extension of the inflammation to the neighboring organs are of greatest importance. When the inflammation is restricted to the gall bladder, as is the case during the first or second day of the attack, the results are good, even with elderly patients. Therefore, early operation during the acute

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The early chapters cover the technique of roentgen examination of the skull in excellent fashion. Most of the lesions of the calvarium are also splendidly elucidated. On the other hand, skull fractures are inadequately covered. Ventriculography is well brought out, but encephalography receives too little attention. There is a surprisingly extensive description of arterioencephalography and of many of the rarer conditions, such as hydatid and cysticercus calcifications, calcification of the caudate and lenticular nuclei, and others. The chapter on the spine and spinal cord is rather short.

Certain statements are open to question. We would disagree, for example, that myelography in the recumbent position is worthless, that ventriculography is of little value in the meningiomas, or that fractures of the vertebral bodies unite completely in six weeks while fractures of the transverse process commonly unite by fibrous union. Aside from a few such statements, however, the facts presented are substantially correct.

While the diagrams are excellent, the number and the size of the roentgenograms are insufficient. Attention should be called to the error by which the same roentgenogram used in Fig. 72 was apparently repeated in Fig. 74, which illustrates another case.

On the whole this is an authoritative, easily read, well-indexed reference book on neuroradiology which should become indispensable to anyone interested in this field of diagnosis.

Textbook of Pathology. A Correlation of Clinical Observations and Pathological Findings. By Charles W. Duval and Herbert J. Schattenberg, M.D., Tulane University School of Medicine, New Orleans, La. Cloth. Ed. 1. Pp. 681, with 373 illustrations, 13 in color. New York, 1939, D. Appleton-Century. \$8.50.

Including the index and the references, there are 681 pages, with 373 illustrations and 13 colored plates. Most of the photomicrographs are satisfactory, but there are many drawings that have a semidiagrammatic appearance. The colored plates of the blood are good.

The authors have presented a rather unfortunate classification of many diseases. Thrombosis, embolism, and infarction are regarded as diseases of the hematopoietic system; edema is a disease of the skin; typhoid fever, trachoma, and undulant fever are diseases of the reticuloendothelial system; while Gaucher's disease and Schüller-Christian's disease (which are truly reticuloendothelial) are classed with the lymphadenomatous system.

There are good discussions of malaria and of leprosy, although the statement is made that *B. leprae* grows readily on artificial media. There are chapters on the pathology of the eye, ear, nose, and throat and a final chapter on the autopsy.

The poorest chapter is the one dealing with nephritis. The old terminology of "chronic interstitial" and "chronic parenchymatous" is used. Fig. 212, labeled acute glomerulonephritis, shows a fairly normal glomerulus; and Fig. 221, labeled chronic parenchymatous, is apparently a hypertensive kidney. The utmost confusion prevails throughout this chapter.

Apart from a few good chapters, the volume is ordinary descriptive pathology of no special merit. The discussions are seldom thorough or fundamental and many important topics are dismissed with scant consideration.

I have noticed acute gangrene in 14 cases during early operation and have been able to avoid the perforation peritonitis by the operation. This is very important with older patients. Among these patients the only fatality was that of a 77-year-old man who had, in addition to the gangrenous gall bladder and threatening perforation, a cancer of the pancreas as big as a fist. He died on the fifth day from cardiac insufficiency. All the other patients were cured.

TABLE I
ACUTE CHOLECYSTITIS

	EARLY OPERATION		LATE OPERATION	
	NUMBER	MORTALITY	NUMBER	MORTALITY
Krüger	249	1.2%	50	28.1%
Finsterer	62	3.2%	97	7.2%

The results of the early operations, when the gangrenous gall bladder was removed, were satisfactory. Among 62 cases, apart from the 77-year-old man, a second death, that of a 50-year-old man from pulmonary embolus, is recorded. It is most important in older patients to eliminate wholly the ether narcosis and to operate only under local or splanchnic anesthesia. Among 19 patients between 60 and 79 years of age, only the above-mentioned 77-year-old man died; all others were cured, including 6 patients over 70 years of age.

When the patients come to operation only after unsuccessful medical treatment for the acute attack, the results of such late operation are not as good; but, nevertheless, they are better than with continued medical treatment with the hope of reducing the symptoms and operating during the interval. In 1932 Mentzer reported that of 134 cases of acute cholecystitis at the San Francisco Hospital, 63 cases were treated medically, with a 56 per cent mortality; while 71 cases, which were finally operated upon because of increasing symptoms, showed 25 per cent mortality.

Certainly also with very serious cases occasionally spontaneous healing is possible by perforation of the abscess into the transverse colon. In this way a gangrenous gall bladder may be eliminated spontaneously so that one finds later no gall bladder at all, but only adhesions. Of course, this advantageous event is possible only if there were, owing to repeated attacks, sufficient protecting adhesions formed which prevented the large abscess from perforating into the abdominal cavity under great tension. Stavaki and Veismann, two Russian surgeons, reported 2 cases where they found, upon incising a large subhepatic abscess, the whole gangrenous gall bladder free in the abscess. On my ward a similar case of an abscess incision was observed by chance.

Twenty-four years ago I operated upon a 58-year-old man because of severe duodenal stenosis due to scar. Eight years previously he had undergone a prolonged, feverish gallstone attack, with formation of an abscess. Finally he became so ill that

attack may reduce the mortality markedly. Krüger, a German surgeon, in 1929 reported his results of operations performed during acute gallstone attacks with fever. The early operations had a mortality of 1.2 per cent in 249 cases; whereas, in 50 late operations the mortality rose to 28 per cent. Graham in 198 cases of acute cholecystitis had no deaths with early operation while the disease was still restricted to the gall bladder.

It has been my practice for more than twenty years to operate early during the acute attack. The results are good and all the dangers of postponing the operation are avoided. In cases of young people having the first acute attack, when the diagnosis is not absolutely certain, one may wait rather than operate as in the case of older patients. Nevertheless, even with young patients one is never sure whether a second attack may not be fatal. Let me report an example:

Ten years ago I operated upon a 29-year-old woman on the fifth day of her second gallstone attack. She had demanded the operation during the first attack five months previously because she had had relatives who had died following delayed operation, but the attending doctors had advised against operation. I saw the patient on the fifth day of the acute attack of common duct obstruction; she had fever and jaundice. An internist had urgently advised operation because of acute pancreatitis. The cause of the obstruction was a stone wedged on the papilla, which caused the acute pancreatitis. I was able to remove the stone only after transduodenal choledochotomy. Despite the operation, the pancreatitis progressed. The patient died thirty-six hours later, protesting that she would not have died if she had been operated upon during the first attack, as she had requested.

Of greatest importance is the early operation during the acute attack in patients over 60 years of age, because experience shows that in these cases the gall bladder quickly becomes gangrenous and perforates. While gangrene of the appendix, also a very frequent occurrence with elderly individuals, is accompanied by a characteristic acceleration of the pulse and often a normal temperature; on the other hand, this increased pulse rate does not appear as frequently in cases of gangrene of the gall bladder, so that, apart from the local point of tenderness, there is scarcely any symptom until suddenly perforation occurs. Therefore, one can understand why in these cases one rarely makes the diagnosis before operation, as illustrated by the following case:

Five years ago I operated upon a 65-year-old man who had never been ill. Forty-eight hours previously he had become ill with indefinite abdominal pain. The patient had no stools, no flatus; therefore, he was sent to the hospital with the diagnosis of intestinal obstruction. Temperature was normal; pulse, 80; but his right hypochondrium very tender on pressure. Therefore I gave the diagnosis of paralytic intestinal obstruction due to acute cholecystitis. I advised an immediate operation, which was performed with splanchnic anesthesia and showed to my surprise a perforation of a gangrenous gall bladder and peritonitis, owing to lack of adhesions. There was no stone in the gall bladder. Cholecystectomy with drainage was carried out. A bile fistula persisted for a long time.

TABLE II
TYPE OF OPERATION

	CHOLECYSTOSTOMY		CHOLECYSTECTOMY	
	NUMBER	MORTALITY	NUMBER	MORTALITY
Pratt	22	10 (45%)	23	0
Finsterer	9	4 (44%)	152	5 (3.2%)

nevertheless, its mortality is higher because an intensely inflamed organ is left in the abdominal cavity from which the inflammation may spread to the deep bile ducts and, above all, to the pancreas. I have carried out cholecystostomy only 9 times, and then because the attendant internists were absolutely opposed to the extirpation of the gall bladder. Of these, 4 cases died. Especially important is the following case:

A 58-year-old woman was operated upon on the fourth day of the acute attack. She was unconscious, with a temperature of 103° F.; pulse, 130. I found a phlegmon of the gall bladder with malodorous pus but no adhesions. Although the gall bladder was freely movable and therefore cholecystectomy would have been very easy, I left the gall bladder because the internist present at the operation was absolutely opposed to cholecystectomy. Therefore, only the stones were removed and the gall bladder and its vicinity were drained. The early postoperative course was good. The patient passed stools and flatus on the second day and had a normal pulse. On the ninth day there was an increase of the pulse rate and pain in the left epigastrium, such as occur in cases of acute pancreatic necrosis. On the eleventh day there was exitus from progressive pancreatic necrosis. At the operation the pancreas had been normal, without even edema; infection ensued only later. In this case cholecystectomy certainly might have saved the patient.

The results of cholecystectomy are good also in cases of acute cholecystitis, for among 152 cases there were only 5 deaths (3.2 per cent mortality). Also, Pratt had a similar experience with acute cholecystitis. While 23 cases of cholecystectomy were all cured, there were 10 deaths among 22 cholecystostomies (45 per cent mortality). Therefore, cholecystectomy can be recommended as the method of choice also during the acute attack.

The internists always assert that the dangers of operation during the acute attack are much greater than the risks of medical treatment, but this contradicts the above-cited communication of Mentzer's from the San Francisco Hospital where medical treatment of acute cholecystitis had a 56 per cent mortality and the late operation, but 25 per cent. It was advised to perform the operation only if absolutely necessary because of diffuse peritonitis or acute pancreatitis. But the diagnosis of perforation peritonitis is particularly difficult, because there is usually no perforation pain similar to that in perforation of an ulcer; on the contrary, immediately after perforation patients even feel some relief because the painful tension of the gall bladder ceases with the emptying of its contents. Also, the accelera-

operation was deemed impossible by the attending internist. Healing had taken place by discharging pus with the stool. At the operation (gastroenterostomy) I intended also to remove the gall bladder, but could not find it. There was only scar tissue above the dilated common duct, although the gall bladder was repeatedly palpable during the preceding attacks as a painful tumor. In this case, there being no ulcer, permanent relief was obtained by simple gastroenterostomy. The patient is now 82 years of age.

When the inflammation is confined to the gall bladder or an abscess forms about the gall bladder, satisfactory results may be obtained with the late operation even with older patients. I have had 7 deaths among 97 cases (7.2 per cent mortality). Among these deaths there was a 71-year-old woman whose gangrenous gall bladder had already perforated into the duodenum. The duodenum was sutured and a cholecystectomy performed, but a duodenal fistula developed; therefore, jejunostomy was done six days later; nevertheless, death from inanition occurred. On a 73-year-old inebriate (the patient had drunk 1 to 2 liters of wine daily for thirty years) in bad general condition sent to operation after a week with peritoneal symptoms (temperature, 103° F.; pulse, 128; emphysema of highest degree) I found a phlegmon of the gall bladder before perforation; moreover, there was an advanced alcoholic liver cirrhosis. The patient died from insufficiency of the heart. Another patient died of uremia. Two patients, one of whom was a woman weighing 275 pounds, died from obesity and insufficiency of the heart; one death was due to pancreatitis.

The opponents of operation during the acute attack assert that the risk of peritonitis is too great, operation therefore being contraindicated. By operating cautiously and carefully walling off by compresses the field of operation from the free abdominal cavity before the cholecystectomy, one easily may avoid the fatal peritonitis. Up until now I have not seen one death from diffuse peritonitis in a series of 161 cases operated upon during the acute attack, although in 13 cases a big abscess near the gall bladder was found. Smith, of New York City, did not have a death from peritonitis in 107 acute cases. Krüger had only one death from peritonitis among 249 cases. Coming upon a large abscess immediately after cutting through the abdominal wall, the surgeon will content himself with simple incision. In these cases there remains quite often a bile fistula. I have operated upon 15 cases in such a way without any death; they are not included in these statistics. Finding an abscess near the gall bladder after opening the abdominal cavity and packing the field of operation, while severing the adhesions, one may remove the gall bladder without any risk. I have never seen any damage result from this procedure; diffuse peritonitis has never occurred, but I always leave in a drain.

It is an important question whether cholecystectomy is preferable to cholecystostomy. The drainage of the gall bladder after removal of the stones is certainly technically easier than cholecystectomy;

failure of complete cure. Of these, 2.8 per cent were due to cholangitis; the others suffered from colitis or duodenal ulcer.

TABLE III
PERMANENT RESULTS OF CHOLECYSTECTOMY

	CHRONIC CHOLECYSTITIS	ACUTE CHOLECYSTITIS
Cured	142 (79.7%)	64 (91.4%)
Improved	12 (6.7%)	4 (5.7%)
Failure	24 (13.5%)	2 (2.8%)
Total	178 cases	70 cases

In 70 cases where operation was carried out during the acute attack, 64, or 91.4 per cent, were well for periods ranging from four to twenty years postoperatively. Four cases are suffering from slight hyperacidity, but they are content with the result of the operation, as they are relieved of their severe pain. There are, thus, 97.1 per cent satisfactory results.

On one uncured patient who suffered a chronic cholangitis, I performed a choledochoduodenostomy, and this patient has been well for ten years. In the second uncured case there was a duodenal ulcer complicated by massive hemorrhage. Since a radical gastrectomy twenty-two years ago, this patient has been perfectly well.

From my experience with the operation performed during the acute feverish gallstone attack, in opposition to the hitherto prevailing opinion, I should recommend the early operation during the acute attack as the most reliable method of treatment, which, by eliminating the ether narcosis, considerably reduces the operative mortality, avoids the risks of a later complication, and, by the removal of the diseased gall bladder, delivers the patient wholly and permanently from any complaint in more than 90 per cent of the cases.

The common duct obstruction by a gallstone is a very serious complication. The medical treatment is of long duration and uncertain success, and the surgical treatment is feared by most practitioners and internists because of its ostensibly great dangers, so that the patients are sent to operation only with absolutely urgent indications. The internists' and surgeons' opinions concerning the best time for operation are divided. While most surgeons ask for the earliest possible operation, the internists prefer waiting at least four to six weeks in the hope that the stone will pass through the papilla. They base this hope upon the observation of cases where jaundice disappeared after a few days' treatment, a fact they explain by the passing of a stone through the papilla. I will not contest the possibility that a little stone may pass through the papilla; also I will agree that regular rinsing of the duodenum with sulfate of magnesia renders good service on application of the duodenal tube accompanied by a prescription containing an antispasmodic. The results of such treatment can be

tion of the pulse takes place very late. If the common duct is blocked, much bile flows into the abdominal cavity; the pulse rate is not accelerated. By the resorption of the bile, it may come to bradycardia, rendering the diagnosis difficult, just as when the bradycardia appearing after hepatic injuries, the diagnostic importance of which I pointed out twenty-five years ago, makes the diagnosis of acute hemorrhage impossible. Therefore, such patients with perforation peritonitis come too late to operation; recovery is to be expected at best only in young patients. I have had 5 recoveries among 11 cases of perforation of the gall bladder with diffuse peritonitis; among these was a 71-year-old woman who, three months later, had a perforated gangrenous appendix, with diffuse peritonitis, from which she also recovered.

Much more dangerous is the spread of the inflammation to the pancreas and the development of acute pancreatic necrosis. In the literature, it is true, some recoveries are reported. Thus, Orator and Straaten report 8 recoveries among 18 cases at Haberer's clinic. I myself have lost all of my 7 cases of acute cholecystitis and pancreatic necrosis, despite operation and regardless of whether the gall bladder was removed or, owing to the bad general condition, only drained. In the literature one continues to find reports of recoveries despite a simultaneous pancreatitis. To be sure, these are cases of the so-called first stage of the acute pancreatitis, of edema of the pancreas, which I also observed in cases of acute phlegmonous gall bladder; but, as it is a simple collateral edema which can be found about every inflammation, I did not include it among the cases of acute pancreatitis.

When with more prolonged acute inflammation not only an abscess near the gall bladder is formed and ascending infection of the bile ducts with chills is started, but also septicemia is to be diagnosed because bacteria (streptococci, staphylococci) are found repeatedly in the blood; by then the operation is too late, for by the operation we may remove the primary focus, but we cannot cure the septicemia. Whether, after extirpation of the diseased gall bladder, the organism can overcome the already present infection cannot be predicted. Because such a patient perhaps can be cured only by the cholecystectomy, I attempt the operation, even if, as my own observations show, the operation may not be successful.

By the early operation in acute cholecystitis, not only we may reduce the immediate operative dangers and prevent fatal complications but also by the cholecystectomy we may relieve the patients permanently from their complaints. At re-examination of all patients operated upon because of gallstones, I noticed four years ago that the best permanent results were obtained by cholecystectomy during the acute attack. In 142 cases where the interval operation was carried out from four to twenty-two years previously, there were 13.5 per cent

papilla; the occlusion may be loosened by regular duodenal washings, owing to which the spasm of the sphincter Oddi ceases, the papilla distends itself, and the stone, if it be not too large, passes. For this purpose, a treatment of one to two weeks is sufficient. If the occlusion persists, there is usually a big stone that can pass into the duodenum only after forced dilatation and rupture of the papilla or after a decubital ulcer of the papilla has perforated into the duodenum. These are the cases in which one finds at operation during the interval after previous jaundice that the papilla is narrowed; despite the dilatation of the papilla, colic occurs after the cholecystectomy. These attacks of colic are clinically explained by common duct stones overlooked or formed afresh, while relaparotomy shows only a dilated common duct with muddy bile, a narrowed papilla, but no stone. These cases are curable permanently only by a choledochoduodenostomy.

If the common duct obstruction is accompanied by fever and chills, according to my opinion one has to operate as soon as possible to prevent ascending infection of the bile ducts and formation of liver abscesses; or, if these conditions already are present, to cure them by restoration of free bile discharge. Within the first weeks, fever may be explained by mere cholecystitis; there may not be even a stone obturation of the common bile duct, as was shown above. Denk advises in cases of jaundice with fever to combat the infection first by medical treatment and to remove the obstruction by operation only after decrease of the fever; he has had a higher mortality when he operated upon these cases in the first weeks than when he operated for common duct obstruction without fever after two months or more. I cannot agree with this suggestion. Only if the jaundice is caused by compression of the common duct and the fever by purulent cholecystitis, can one perhaps expect success by conservative treatment. With stone obstruction and ascending infection, the cure of the infection is impossible without simultaneous removal of the occlusion. The patients at last become so feeble by the permanent fever and chills that operation is then declined; they die without operation, just as the patient refusing the operation, as the internist Eppinger, one of the best experts of liver disease, has hinted in his book on liver diseases published a year ago.

If, according to the internists' proposal, the operation is postponed for four to six weeks or more, the dangers of operation are increased because of the progressing liver damage, ascending infection of the bile ducts, and cholemic postoperative hemorrhage. The mortality will be higher with these late operations, just as with acute cholecystitis. If one intends to obtain any success in such advanced cases, he must act according to these three factors. On account of the already existing liver damage, any further damage of the liver absolutely must be avoided. The liver must not be traumatized by retrac-

determined in one to two weeks. With this method I have seen really good results, so that the operation could be avoided. Therefore, within the first weeks, when fever or chills are wanting, I recommend an attempt with the duodenal tube, but I advise an operation if no result is obtained after two weeks of treatment.

When jaundice with wholly acholic stools accompanying the acute gallstone attack disappears after some days, with the decrease of the pains, there is no proof that in such a case a stone has passed out through the papilla. It is much too little appreciated that a complete common duct obstruction can occur without any stone in the duct. This obstruction results from the following circumstances: the cystic duct is obturated by a stone during the acute gallstone attack; the enormously strained gall bladder, its head fast fixed on the liver bed and therefore not able to extend itself forward, distends itself on its neck; the common duct lying beneath is so thoroughly compressed between gall bladder and vertebral column that no bile passes at all. This state can indisputably be found during operation for an acute attack. After emptying the overdistended gall bladder by puncture, the pressure on the common duct is completely relieved and the bile flows at once into the duodenum and stomach and may be vomited. This manner of common duct obstruction I could ascertain without doubt in 13 cases as follows: Some patients who before had wholly acholic stools vomited bile after the puncture of the gall bladder; at choledochotomy no stone was found and the papilla was permeable. One cannot suppose that quite incidentally, not in 1 case but in 13 cases, the stone passed through the papilla, just at the moment of the operation made with local anesthesia; one can never pretend that the stone occluding the papilla, upon decrease of the tension, owing to the puncture of the gall bladder, no longer was pressed against the papilla, the discharge of the bile thus being possible again; but that the stone could not be found in the common duct by any means at the following examination. All the patients have remained, from the operation until now (that is, for a period of twelve years), free from any complaints, a condition which would be impossible if a so-called pendulum stone were left in the common duct.

A similar event occurs in the successful medical treatment of the gallstone attack. By means of an antispasmodic the tension of this overdistended gall bladder relaxes, the pressure upon the obturating stone in the neck of the gall bladder ceases, and with the slightest movement bile can flow off: the gall bladder empties itself through the cystic duct, whereby the pressure upon the common duct ceases. With the decrease of pain and cessation of the attack, there is a disappearance also of the jaundice caused by compression of the common duct and not by a stone in the common duct. If the stools remain acholic after cessation of the attack, there is a stone obturating the

once suggested that cholemic hemorrhages are not caused by the presence of bile in the blood but by deficiency of bile in the intestines; therefore, one ought to bring the bile as soon as possible into the intestines. This assertion would be supported by the researches of Graves and Schmidt, who, in cases of bile deficiency in the intestines, noticed a decreased absorption of the vitamin D which is stored in the liver and which reduces the time of blood coagulation. Because of my performing mostly choledochoduodenostomies, freedom from cholemic postoperative hemorrhage may be the result of the advantageous effect of the internal biliary drainage.

The ascending infection of the bile ducts is most effectually combated by stimulation of the bile secretion after the operation and by free discharge of the bile. To achieve this, cholagogues of all sorts are used. Their administration immediately after the operation, however, is rendered difficult. In such cases I use decholin, introduced into the therapeutics of gallstone disease by Neubauer. Patients receive, when highly feverish, an intravenous injection of 10 c.c. decholin (20 per cent dehydrocholic sodium) on the second day after operation; the injection is repeated within the following two to three days until the fever decreases. Later, medical remedies may be applied.

The removal of the stone responsible for the obstruction usually is not sufficient to ensure free bile drainage into the duodenum, because the flow temporarily may be interrupted owing to swelling of the papilla and spasm of the sphincter of Oddi. Therefore, in these cases one has to eliminate at least the function of the sphincter by forced dilatation of the papilla, as performed by Bakes, Walzel, and other surgeons. A free drainage is better obtained by common duct drainage or by choledochoduodenostomy. The common duct drainage is surely the more simple operation, but its mortality is of a high degree, because the patients obviously do not tolerate well prolonged bile loss and the risk of postoperative hemorrhage increases. Friedrich reports that at Hoch-

TABLE IV
COMMON DUCT OBSTRUCTION
MORTALITY

	COMMON DUCT DRAINAGE		CHOLEDOCHODUODENOSTOMY	
	NUMBER	MORTALITY	NUMBER	MORTALITY
Jurasz	73	20.5%	47	4.2%
Finsterer	22	5 (22.7%)	62	6 (9.6%)

enegg's clinic the mortality of the common duct drainage amounted to 32 per cent; at Haberer's, 28 per cent. Jurasz with common duct drainage had a 20.5 per cent mortality among 73 cases, while among 47 cases of choledochoduodenostomy only a 4.2 per cent mortality occurred. During my first years in practice, I also applied the common duct drainage, but during the last twenty years I have been using it very infre-

tion during the whole operation, even though the operation is rendered a little more difficult, because in this stage the liver is particularly sensible to any trauma. I regard rolling of the liver out of the abdominal cavity over the costal arch as especially dangerous; therefore, I never have used this procedure in my gall-bladder operations. Also, ether narcosis must be wholly eliminated. We know today that ether is a dangerous liver poison whose toxicity increases with the quantity and concentration of the ether used. Crile, in his excellent book on *Surgical Shock and Shockless Operation Through Anoci-Association*, has proved this by many animal experiments. He also has shown that nitrous oxide does not exert the same toxic effects. While the normal liver recovers from this toxic process in a short time, a liver already injured by disease becomes incapable of recovery, owing to summation of the damages. The result is death from insufficiency of the liver, often called simple shock death. For the past twenty-five years I have operated upon cases of common duct obstruction only under local anesthesia of the abdominal wall and splanchnic or paravertebral anesthesia and have no death to report from insufficiency of the liver, despite many critical cases. I suppose that my good operative results are due to the avoidance of deep ether narcosis.

For combating the postoperative hemorrhage in jaundiced patients, different methods have been suggested, the efficiency of which is not generally acknowledged. It is easy to understand that blood transfusions before and after the operations are advantageous, even if only for substituting the lost blood and for the lesser effect on the blood coagulation. For fifteen years I have made prophylactic x-ray irradiation of the spleen with $\frac{1}{3}$ E. D., according to the suggestion of an Italian surgeon, in order to increase the blood coagulation. The irradiation must be made immediately before the operation, for, if too long a time should elapse between the irradiation and the operation, the desired effect on the coagulation time may be at its height during the operative procedure. This results in imperfect hemostasis at the operation and the occurrence of postoperative hemorrhage. Fifteen years ago I saw this happen in a case of jaundice caused by cancer of the pancreas which had been irradiated twenty hours before the operation. During the operation, there was remarkably little bleeding in spite of normal blood pressure; twenty-four hours postoperatively, hemorrhage set in. Since then I have made the irradiation immediately before the operation. The real effect of the method is difficult to prove; still, these last fifteen years I have seen only two deaths from cholemic postoperative hemorrhage; in one case there had been previous irradiation, while, in the other, the irradiation of spleen was technically impossible. I consider it more important to avoid the external drainage of the common bile duct in these cases and to drain the bile directly into the intestine by choledochoduodenostomy. The Russian surgeon Grekow

In performing a supraduodenal choledochoduodenostomy, an incision 2 cm. long is made in the common duct, starting at the junction of the cystic and common ducts and extending distally; an incision of similar length is made in an appropriate area in the upper border of the duodenum. A two-layer anastomosis with interrupted sutures is carried out; the anastomosis is then covered with omentum; laterally to the anastomosis a drain is placed so that, in case there be a leak in the suture line bile will not then drain into the abdominal cavity. Moreover, the patient is placed for at least forty-eight hours in high Trendelenburg position. The anastomosis has to be sufficiently wide and must remain broadly open in order that the discharge of bile is unhindered. For this reason the transverse incision of the common duct applied by Sasse and Heyrovsky often failed. Through the wide anastomosis the bile will drain freely and thus cure sometimes even the worst cases of purulent cholangitis with superficial liver abscesses. Two examples follow:

A 75-year-old woman for three months suffered pain, fever and vomiting; for two months, jaundice with acholic stools, daily fever 102 to 103°, chills, vomiting up to twenty times a day, advanced emaciation and debility; finally a necessarily late operation was declared impossible by five internists and was refused by two surgeons. Because of the special requests of her children to attempt at least to save her life, the patient was operated upon May 29, 1927. For the local and splanchnic anesthesia only $\frac{1}{4}$ per cent novocain solution was used. The cecum and appendix were found to be adherent to the gall bladder. Upon performing appendectomy, a thickened gall bladder covered with fibrin and containing many stones was found; the common duct was more than 3 cm. wide and contained a big obturating stone on the papilla and many small stones; the liver was large, surprisingly soft, and contained on its surface multiple small abscesses. Cholecystectomy and choledochotomy were performed after removal of the stones from the common duct; only pus was drained; a 2 cm. wide choledochoduodenostomy was performed. The first two days there was repeated vomiting, for which the stomach was rinsed. Fever continued and decholin intravenously was given. The fever slowly decreased. The patient recovered with increase of weight up to the normal and is without any complaint at the present date. She is now 86 years old. At the x-ray examination the bile ducts were found to be filled with barium only when the patient had been lying down for a long time on her right side.

A 70-year-old woman had had gallstone attacks for fourteen years. For the last year there had been a great many attacks and repeated jaundice. For three months there was complete obstruction of the common duct with fever: for one week, daily chills, high fever, repeated vomiting. Operation was declined by two surgeons. At her daughter's explicit request, the patient was admitted to the hospital for operation almost moribund. Temperature was 104°; pulse, 132, small and irregular; abdomen, distended and everywhere very tender to pressure. Operation was performed May 25, 1928. Because of the patient's unconsciousness and restlessness, the operation was begun under nitrous oxide narcosis, with local anesthesia of the abdominal wall; later splanchnic anesthesia was administered and the nitrous oxide was discontinued. Laparotomy was performed along the costal arch. There was a large amount of purulent bile between the right diaphragm and liver and also in the lower abdomen, without a perforation being found; the thickened gall bladder contained no stones; the common duct and hepatic duct were considerably dilated and contained a big stone wedged in the ampulla and twenty-nine small stones; the liver was enlarged,

quently, its mortality, compared with choledochoduodenostomy, being of a high degree; among common duct drainages I have had 5 deaths (22.7 per cent) and in addition 3 late deaths from inanition due to a persisting bile fistula, so that the mortality is exactly 36.3 per cent. Surely with these 3 deaths, all in cases operated upon before the War, deaths from bile fistula could have been prevented by choledochoduodenostomy, which at that time I did not know. The choledochoduodenostomy, however, has a 9.6 per cent mortality (62 cases with 6 deaths), although there were many very severe cases; in 32 cases the common duct obstruction had lasted two to twelve months; in 36 cases there was moreover purulent cholangitis with high fever and chills; 39 patients were 60 to 79 years old. Among these 6 deaths, 2 were due to bile peritonitis, avoidable by better technique; 2 were caused by cholemic postoperative hemorrhages. A 72-year-old patient with advanced arteriosclerosis died the ninth postoperative day from insufficiency of the heart and pneumonia. At the post mortem the abdomen was all right. A 69-year-old patient came to operation with chills and high fever. I found empyema of the gall bladder and purulent bile in the common duct, but no stones. The patient died after four days. The post mortem showed intense bilateral purulent bronchitis, acute dilatation of the heart, acute splenitis, purulent cholangitis, and multiple liver abscesses, especially in the right lobe. The anastomosis was all right; there was no peritonitis.

The choledochoduodenostomy can be made transduodenally with splitting of the sphincter or above the sphincter. This method was only seldom applied, despite the recommendation of Lorenz and Moszkowicz, because its mortality is high (more than 20 per cent) and it is particularly dangerous in cases where the common duct is not lying close to the duodenum but is passing up to the papilla across the pancreatic tissue. In such cases, after incising the pancreatic tissue, it may be difficult to control the hemorrhage, but above all an acute pancreatitis is almost unavoidable. Therefore, I have applied the transduodenal choledochoduodenostomy only if the stone wedged on the papilla could not be pushed higher even after mobilization of the duodenum. I have had 1 death among 5 cases.

A 47-year-old woman suffered for two and one-half months with complete obstruction of the common bile duct and petechiae. Despite preparation and blood transfusion before and after the operation, postoperative hemorrhage occurred. Two further transfusions, however, controlled the hemorrhage. The patient died, however, from acute pancreatitis.

The permanent results in the cases of transduodenal choledochoduodenostomy are excellent. Three cases are without any complaint after sixteen to seventeen years; one woman has gained 27.27 pounds in weight. The results of one case remained unknown.

With 24 cases the operation was performed eleven to seventeen years ago so that one may really speak of permanent cures. Two patients are sometimes afflicted with ulcer complaints which disappear again after medical treatment; one patient suffers from chronic colitis which existed before the operation. There is no uncured case nor any case of ascending infection.

The permanent results of the common duct drainage or suture of the common duct are not so good. Floercken had only 51 per cent permanent cures. Bernhard reports about 30 per cent from Popper's clinic. I have, among 13 cases of common duct drainage or suture of the common duct, 5 cases cured, 1 improved, 7 uncured, among which are 3 cases with persisting bile fistula.

Choledochoduodenostomy gives excellent results also with chronic pancreatitis. I used it on 10 patients, all of whom recovered. Seven cases are absolutely cured after three to twelve years; 2 cases were operated upon only four months ago; 1 case died from liver metastases after one year. Also, in cases of chronic pancreatitis, I prefer choledochoduodenostomy to cholecystostomy, cholecystectomy, or dilatation of the papilla, which is still frequently commended but which often leads to failure.

I have applied choledochoduodenostomy also in those patients who had further complaints referred clinically to gallstones left behind in the common duct after cholecystectomy. These stones were not discoverable at the operation, but instead a relative stenosis of the papilla partly by cicatrization, partly by swelling of the head of the pancreas was found. I performed the operation 10 times without any deaths; 8 cases are wholly free from complaints after a period of three to ten years; 2 cases operated upon only six months ago are not applicable for the evaluation of the permanent results. Among these, one patient is particularly interesting; he was operated upon ten years ago by Walzel because of stones in the common duct. At that time, apart from the cholecystectomy, the dilatation of the papilla was performed. One patient suffers sometimes from chronic colitis. One patient is uncured. He sometimes has severe pains and also jaundice. Here repeated x-ray examination shows that the bile duct does not fill; the anastomosis, therefore, has closed.

From my experience, I communicate the following rules for my treatment of common duct obstruction by stones:

1. In all cases the diseased gall bladder is removed.
2. If the common duct be occluded by a solitary stone and the papilla be permeable, the common duct is sutured after extraction of the stone and only the abdomen is drained.
3. If the papilla be stenosed and not dilatable, choledochoduodenostomy is applied.

was surprisingly soft, and on its surface had many small abscesses. Cholecystectomy and choledochotomy were performed; after removal of the obturating stone and the small ones, only pus flowed from the common duct. A 2 cm. wide choledochoduodenostomy was performed. During the first two days, the patient was still unconscious and passed almost no urine (50 c.c. within twenty-four hours) despite infusions of sodium chloride; high fever continued. From the second day intravenous injections of decholin were given with gradual decrease of the temperature; healing was retarded by persistent infection of the abdominal wall. There was a postoperative weight increase of 25 pounds. In 1934 the x-ray examination showed the bile ducts filling only in the right side position. The patient, then 80 years of age, was re-examined in 1938; there were no complaints or fever from the bile duct; only the big ventral hernia troubled the patient occasionally.

Choledochoduodenostomy is relatively seldom performed for fear of ascending infection. It is regarded as indicated only when there is a complete obstruction of the common duct by cancer of the pancreas, if a cholecystoduodenostomy cannot be performed. Mallett-Guy has collected from the literature 12 cures and 8 later deaths of ascending infection and has warned against this operation because of its 40 per cent mortality. From my own experiences I have contested this argument repeatedly and have showed that this lack of success does not occur with the typical side-to-side anastomosis, but only with the end-to-side anastomosis, because the latter tends to stenosis and thus permits the ascending infection because of imperfect drainage of the common duct. I could show that just those cases whose bile ducts fill on x-ray examination give excellent permanent results. The following is an example:

A 64-year-old man was operated upon in 1922 because of common duct obstruction, with fever and chills (for four weeks daily 39°; daily chills). The common duct and hepatic duct were very dilated and contained twenty stones and purulent bile. After cholecystectomy, a 2 cm. wide choledochoduodenostomy was performed. The patient up to now is wholly free from any complaint and has gained 55 pounds in weight. X-ray examination with barium per os shows a complete filling of the ramifications of the hepatic ducts; nevertheless, complete health has been maintained for eighteen years without any change.

TABLE V
END RESULTS

	COMMON DUCT DRAINAGE	CHOLEDOCHODUODENOSTOMY
Cured 3 to 17 yr.	5	42 = 93.3%
Improved	1	3 = 6.6%
Failure	7	0

The permanent results of the choledochoduodenostomy are very good. Among 48 cases operated upon, three to seventeen years ago, 2 cases died within 3 years from cancer of the pancreas with liver metastases; one 72-year-old patient, after complete good health, died from grip-pneumonia. Forty-two of the remaining 45 cases, or 93.3 per cent, were free from complaints for from three to seventeen years, gained their normal weight, and never had fever and spasms of jaundice.

SOLITARY NONPARASITIC CYST OF THE LIVER

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UNUSUAL abdominal tumors are of interest because they so often defy clinical diagnosis. Davis¹ extensive study of nonparasitic liver cysts revealed 187 reported cases of a solitary cyst to which he added one. This indicates a recently aroused interest in this condition as Stoesser and Wangenstein's² review only eight years previously placed the number of cases on record at 104. Although much has been written about the symptoms produced by these tumors, very few have been recognized clinically. Many have been mistaken for ovarian cysts, while hydrops of the gall bladder,³ mesenteric cyst, and hydatid cyst have been other favorite preoperative diagnoses. Harrington, of the Mayo Clinic (in a personal communication to Jones),⁴ states that three of their series of twenty-five cases were diagnosed as tumors or cysts of the liver. Despite the rapidly increasing number of such cases reported in recent years, it seems that the condition is still sufficiently rare to warrant placing on record another.

CASE REPORT.—Mrs. E. L., aged 20 years, entered the Evanston Hospital complaining of frequent pain and a sense of fullness in the abdomen. She had been conscious of a gradual increase in the size of her abdomen for about one year. Six months previously she had suffered a severe attack of abdominal pain which was confined chiefly to the lower abdomen. When examined at that time, tenderness was found most marked in the right lower quadrant and a diagnosis of acute appendicitis was made. The W.B.C. was 11,500. The symptoms subsided rather rapidly, however, and an expectant course was advised. She states that since this episode very few days had passed that she had not experienced some abdominal discomfort. She had noticed an increasing tendency to constipation and the act of defecation sometimes occasioned pain, particularly in the suprapubic region; she felt that there was some obstruction near the outlet which interfered with elimination. Dyspareunia was also mentioned. For the past few months her menses had been about a week late; there was no intermenstrual bleeding and no dysmenorrhea. Physical examination indicated a well-nourished but somewhat pallid young Italian girl whose abdomen exhibited a fullness which appeared abnormal. The abdomen was everywhere tender to palpation but most sensitive just above the pubis. Percussion indicated the presence of encapsulated fluid which was easily ballotable; the fundus of the tumor appeared to occupy the lower abdomen. Pelvic examination disclosed a tumor which seemed to lie above the tip of a freely movable, normal uterus and whose upper limit could be palpated just above the umbilicus. The W.B.C. was 10,700; R.B.C., 4,890,000; Hb., 13.5 gm.; and the urine was essentially negative. A diagnosis of ovarian cyst was made and surgery advised. A low midline incision was made and the peritoneum opened. A large bluish walled cyst was seen to occupy almost the entire abdominal cavity (Fig. 1). Exploration of the pelvis furnished proof that the tumor was independent of any of

resembling an inner tube of a tire is removed. It is 1-2 mm. thick and composed of homogeneous, resilient, dull green, fibrinous cast with 1-3 mm. ochre yellow deposits. The wall of the cyst is 0.5-1 mm. thick. Its external surface is smooth and gray and numerous blood vessels course throughout the membrane. The internal surface is smooth, glistening, red, tinged with yellow.

"The second specimen received, which apparently corresponds to the pedicle, has a thicker, more fibrous wall than the cyst. Its inner surface is infiltrated with broad plaques of ochre yellow material. The circumference is approximately 6 cm.

"*Fluid*: Microscopic examination of the fluid reveals a moderate amorphous colorless precipitate, an occasional cholesterol crystal and leucocyte.

"Chemical examination reveals the following: reaction—alkaline; bile—present; cholesterol—present; mucin—faint trace; carbohydrates—negative. Protein—18 grams per liter.

"*Microscopic Description*: Sections taken from the cyst wall near its origin reveal a thick, hyalinized wall partly stained by yellow pigment. The internal surface in some areas is lined by a thin, flattened, nondescript layer of cells beneath which there is a thick erythrocytic extravasation about numerous small single endothelial-lined vascular channels and an occasional slightly thickened, hyalinized vein. In the wall there are also seen several cross sections and oblique sections of tubes lined by cuboidal epithelium resembling bile ducts. A heavy round cell infiltration with an occasional neutrophilic and eosinophilic polymorphonuclear leucocyte is also seen in the wall. Sections taken from the fundus of the cyst show a much thinner collagenous connective tissue wall in which are incorporated numerous small blood vessels. The external surface exhibits no distinct covering. The internal surface is lined by a multilayered narrow columnar epithelium. At the base of the mucosa there is occasionally seen a large macrophage containing yellow pigment. In places the cytoplasm of the macrophages is slightly foamy.

"*Diagnosis*: These findings are compatible with a diagnosis of a congenital cyst of the biliary system."

The etiology of these nonparasitic cysts arising from the liver has not been definitely established. Most plausible is the theory that they arise from aberrant bile ducts.⁵ The discovery of several tubes cut in cross section and lined with cuboidal epithelium would suggest the probability of such a mode of origin in the present instance. Most investigators in this field are agreed that such cysts are congenital in nature. The majority of the pedunculated cysts appear to arise from the under surface of the liver, the right lobe being most commonly involved.

As was stated earlier in this report, very few cases of congenital biliary cysts have been diagnosed prior to operation. Symptoms may be entirely absent. When present, they are due either to pressure, torsion of the pedicle, or rupture of the cyst wall with escape of fluid into the peritoneal cavity. In trying to account for our patient's acute bout of abdominal pain six months previous to operation, it seems not unlikely that a small leak of the cystic fluid through the thin cyst wall may have been responsible. Again, it is entirely possible that this pain may have been independent of the hepatic cyst. The frequent discomfort experienced up until the time of her operation no doubt was due to pressure exerted by the cyst on such organs as the bladder, rectum, and uterus.

the pelvic organs. At its upper end the tumor was found to narrow down to a stalklike pedicle which appeared attached to the under surface of the liver. It was then decided to remove the body of the tumor and make a second incision over the gall-bladder area for further investigation of the pedicle. Accordingly, this plan was carried out, the cyst being sectioned between clamps as high as possible and the original incision quickly closed. A second incision was made obliquely from the xiphoid across the rectus muscle to a point approximately 2 cm. lateral to the umbilicus. The pedicle of the cyst was seen to arise high on the under surface of the right lobe of the liver (Fig. 1). This was carefully dissected free from the substance of the liver, clamping and ligating the large blood vessels contained in the wall of the pedicle as the dissection proceeded. The second incision was then closed in layers.

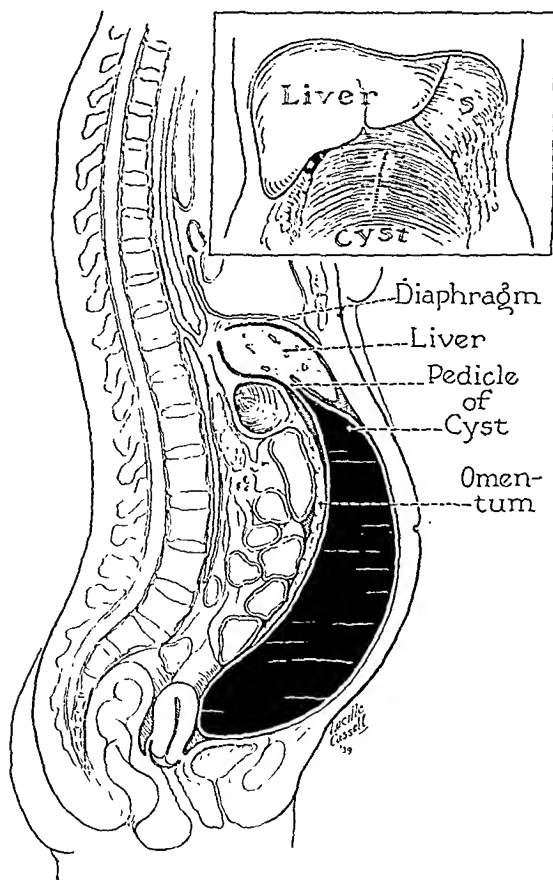


Fig. 1.

The patient made an uneventful recovery and was discharged from the hospital on her eleventh postoperative day. When last seen, eight weeks later, she was in good health and no evidence of any recurrence was found.

A description of the tumor as given by Dr. E. L. Benjamin, pathologist at the Evanston Hospital, is as follows:

Gross Description: This cyst, the size of a child's head, is filled with approximately 2,000 Ml. of thin, turbid, dark yellow fluid. Upon opening this cyst a bag

THE MAINTENANCE OF NUTRITION IN SURGICAL PATIENTS. WITH A DESCRIPTION OF THE OROJEJUNAL METHOD OF FEEDING

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THE nutrition of the surgical patient has become of increasing importance to the surgeon since it has been shown that a variety of complications following anesthesia and operation are the result of prolonged nutritional disturbances. The studies of Goldschmidt, Vars, and Ravdin¹ have demonstrated that the major conditioning factor in the production of necrosis of the liver following the use of volatile anesthetics is the amount of hepatic fat which is present at the time of anesthesia. These workers have found that an abundant supply of hepatic glycogen is efficacious in preventing necrosis of the liver only if the hepatic lipid concentration is reduced as the result of the glycogen deposition. Another factor of considerable importance in the prevention of hepatic injury is the presence of an adequate store of readily available protein. The liver with a high carbohydrate-protein store is maximally prepared for the insult by volatile or lipid solvent anesthetics.

Jones and Eaton² first called attention to the hazards of hypoproteinemia in surgical patients. The experimental and clinical studies of Meecray, Barden, and Ravdin³ confirmed and extended their observations. Meecray and his associates demonstrated that gastric emptying time was greatly prolonged in hypoproteinemia, even in the intact stomach and even though there was no deficiency of any known accessory foodstuff.

Thompson, Ravdin, and Frank⁴ found hypoproteinemia to be associated with a delay in fibroplasia in the dog and suggested that this condition might be a factor in wound disruption in surgical patients. Confirmation of this has now been obtained in several patients who have suffered abdominal wound disruption.

Not only is there frequently a deficiency in the primary foodstuffs, but many of the patients coming for operation also have a subclinical or clinical deficiency of certain of the vitamins. A deficiency in the B complex results in prolongation of the period of emptying of a water-barium meal from the stomach. The small intestinal pattern also is greatly disturbed in a B complex deficiency. Heublein, Thompson, and Scully⁵

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Practically all cases in which the tumor has been removed surgically have gone on to a satisfactory recovery. Apparently the incidence of recurrence is low. Even those cases in which marsupialization² has been carried out appear to have gotten well without return of the condition. Cotton and Burgess⁶ report a recovery following drainage of the cyst. The mortality following surgery has been variously estimated at from 12 to 33 per cent.

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much the patient has actually eaten, so that the actual caloric intake is not known. A diet which contains 60 to 80 per cent of carbohydrate, 20 to 30 per cent of protein, and 5 to 10 per cent of fat in the total calories as a rule is satisfactory. We believe that the level of fat in the diet should be kept as low as possible.

During the period of oral feeding, the intravenous use of glucose is of value more for the effect it has in sparing protein stores than for any other reason. The total calories available from 3,000 c.c. of a 5 per cent glucose solution are 600, which is but one-third of the basal caloric requirements. When no contraindication to extensive oral feeding exists, the patient can readily receive adequate calories by mouth and the intravenous route is not required.

The Orojejunal Method.—As the result either of anorexia, which frequently can be corrected by the administration of brewers' yeast, or of obstruction, adequate oral feeding is often not possible. If the nutritional state of the patient is such that the major operation is extremely hazardous, it is at times wise to perform a jejunostomy to feed the patient. Where early operation is imperative, the plasma proteins may be maintained at a normal level by the use of blood, serum, or plasma. In a later paper we shall discuss the use of these materials.

It has been our experience that, even in patients with roentgen evidence of complete pyloric obstruction from ulcer or cancer, the drainage of the stomach for several days by the method of Wangensteen and Paine⁷ frequently results in the disappearance of some of the edema associated with the obstruction so that a Levin or Abbott tube will pass into the jejunum. When this occurs, intensive orojejunal feeding can be begun.

Where feeding is carried out after a gastric resection or simple gastroenterostomy, the special Abbott gastrojejunal tube⁸ is passed into the distal loop of jejunum before closure of the abdomen (Fig. 1). The Abbott tube permits of suction from the stomach through one lumen (A), and feeding into the jejunum through the other (B).

Either before or after operation, as the case may be, a feeding mixture can be administered through the tube. We introduce the mixture with an apparatus devised by Stengel and Vars (Fig. 2) which permits of automatic feeding, either continuous or intermittent. All that is required is to attach the flasks containing the feeding mixture to the feeder tube. An electrically driven modified DeBakey transfusion pump (A) is connected to the special Abbott tube placed in the patient's stomach just prior to operation and carried into the jejunum at operation. We have used three DeBakey tubes (B) connected together to secure the desired volume output. The sterile protein-glucose-salt mixture is stored in 1 L. flasks (C) and these are connected to the intake of the pump. In addition, a time device has been added to the pump used in our experimental studies. The essential principle of this is the periodic

have shown that the administration of large amounts of thiamin hydrochloride (B_1) and riboflavin (B_2) does not restore the gastrointestinal activity and pattern to normal. This restoration to normal occurs only after the administration of the entire B complex.

Lanman and Ingalls⁶ found that a vitamin C deficiency results in a marked delay in wound healing and their results have been confirmed by Taffel and Harvey.¹⁴ Thus, two nutritional factors, hypoproteinemia and a vitamin C deficiency, are now known to be factors in wound disruption.

The use of vitamin K and bile salts in overcoming the prothrombin deficiency of patients with obstructive jaundice is another example of the importance of nutrition in surgical patients. That an absence of bile salts from the intestinal tract results in the failure of the absorption of vitamin K from the normal dietary has now been amply confirmed. Such a circumstance leads to a reduction of the prothrombin concentration with its resultant tendency to bleeding.

These complications of surgical patients, many of which were previously explained on a mechanical basis, have greatly increased the interest of the surgeons in the state of nutrition of patients who are to be subjected to operation. The frequency with which hypoproteinemia may cause and accentuate the edema around a newly formed gastroenteric anastomosis, so as to mimic in every way a technical defect of the anastomosis, led us to investigate the methods by which the hypoproteinemia might be overcome prior to and controlled subsequent to operation.

METHODS AND MATERIALS

Diet.—It is of primary importance that, where operation is not of an emergency character and where evidence of an existing nutritional deficit exists, an attempt should be made to improve the nutrition of the patient prior to operation. A high carbohydrate-protein dietary is the most satisfactory method of supplying the primary nutritional requirements of the surgical patient, without increasing the hazards of anesthesia and operation.

The oral method is not only the method of choice for the administration of carbohydrate, protein, and the necessary fat, but it is also a very satisfactory route for the administration of the accessory foodstuffs, the vitamins. In fact, certain of these have not been isolated in pure form and are thus not available for parenteral administration.

When the oral route is used, it is important to select a diet which contains foodstuffs which are readily assimilable and which can be given in sufficient amounts, not only to supply the calories for energy requirements, but in addition to replenish deficient carbohydrate and protein stores. The caloric requirements for such a program generally are in excess of those offered in the three-meals-a-day dietary of the average hospital. Even when offered, a record often is not kept of how

much the patient has actually eaten, so that the actual caloric intake is not known. A diet which contains 60 to 80 per cent of carbohydrate, 20 to 30 per cent of protein, and 5 to 10 per cent of fat in the total calories as a rule is satisfactory. We believe that the level of fat in the diet should be kept as low as possible.

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activation of a microswitch by a cam revolving slowly (*E*) on the shaft of a small synchronous telechron motor (*D*) geared down to the ratio of 120:1. The microswitch controls the electric current to the pump's motor. According to the construction of the cam, it is possible to obtain varying periods of feeding with alternate intervals of rest. As a rule

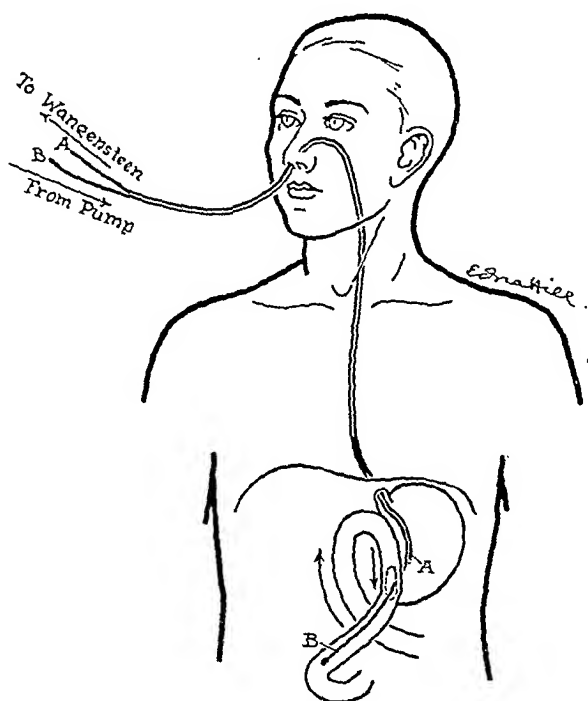


Fig. 1.

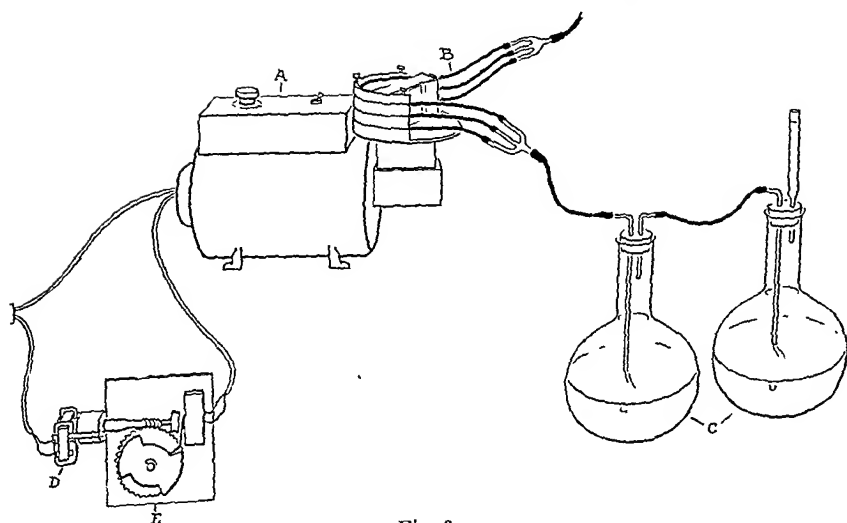


Fig. 2.

we have started the patient on a program of feeding for thirty minutes and an equal period of rest, but when peristaltic activity becomes normal it is possible to feed the patient forty-five minutes out of each hour, or even ninety consecutive minutes out of each two hours. The timing device greatly facilitates automatic periodic or jejunal feeding.

Since some of the patients before operation and many of them for a time subsequent to operation have some interference with enzyme production, the feeding mixture is partially digested so that it may be easily absorbed from the jejunum.

We are using a peptone hydrolysate first made for us by Dr. David Drabkin, of the Department of Physiological Chemistry of this medical school, and more recently supplied to us by Merck and Company. The ratio of amino nitrogen to total nitrogen of this latter preparation is 1:1.87. The partially hydrolyzed peptone is put in solution in boiling water and varying amounts of glucose are added, depending upon the concentration of protein and carbohydrate we desire in the final feeding mixture. In addition we daily add sufficient sodium chloride to maintain a normal plasma chloride concentration. With this method intravenous fluid and salt administration is not required and the patient can be supplied sufficient calories for energy requirements and for maintaining or replenishing a protein deficiency. In the patients in whom we have used this method, we have not pushed the caloric intake but the total calories administered in a twenty-four-hour period can be increased to 1,500 or more daily without the slightest difficulty. It is, of course, obvious that such a program is efficacious only when there is no lesion present which prevents the formation of serum proteins when the components are offered in the dietary.

Control Patient.—The following case history represents what we believe may be expected in patients subjected to gastric operations when no special attention is directed to their nutrition prior and subsequent to operation.

CASE 1.—J. McL., Surgical No. 41078, white male, aged 50 years, was admitted to the medical service of the Hospital of the University of Pennsylvania on Oct. 19, 1938. Some months previously he had been operated upon for a perforated duodenal ulcer. He was still having pain of the ulcer type. The serum protein was 6.5 gm. per cent on Nov. 1, 1938. Just prior to operation, he was given a transfusion of 400 c.c. of blood. Following a subtotal gastrectomy on Nov. 5, 1938, the stomach was kept empty by suction drainage, and fluids, saline and glucose, were given intravenously. The patient received a daily average of 628 calories by this method. On Nov. 12, 1938, the serum proteins were 4.3 gm. per cent.

This patient illustrates the fall in the serum protein concentration which may occur during the period of protein restriction and hydration which often follows operation.

Patients Receiving Orojejunal Feedings.—

CASE 2.—R. C., Surgical No. 40697, white male, aged 21 years, admitted to the medical service of the Hospital of the University of Pennsylvania on Oct. 1, 1938, with a diagnosis of penetrating duodenal ulcer. He was transferred to the surgical service on Nov. 7, 1938. The serum proteins on Nov. 9, 1938, were 7.3 gm. per cent and on the following day a subtotal gastrectomy was performed. The Abbott tube was placed into the distal jejunum after completion of the anastomosis. Following operation he was given a transfusion of 500 c.c. of blood, and saline solution and glucose were begun intravenously. His serum proteins fell to 6.1 gm. per cent. All parenteral fluids were stopped except for 1,500 c.c. given on the third day following operation, and feeding through the Abbott tube was begun on Nov. 11, 1938. He received, by this method, approximately 74 gm. of protein and 181 gm. of glucose daily. Thus, the patient received a daily average of 1,024 calories. In addition, sufficient sodium chloride was added to the feeding mixture to maintain a normal level of the plasma chlorides. On this nutritional program the serum proteins had risen to 6.7 gm. per cent on Nov. 15, which was the final day of special feeding.

CASE 3.—M. F., Surgical No. 40463, white male, aged 52 years, admitted to the surgical service of the Hospital of the University of Pennsylvania on Oct. 23, 1938, with the diagnosis of gastric carcinoma. After suction drainage of the stomach for a few days, a feeding tube passed the pylorus. At this time (Oct. 28) the serum proteins were 7.7 gm. per cent. Following restoration of the fluid and electrolyte balance, the serum protein fell to 6.6 gm. per cent. The feeding program was continued for twelve days before operation, the patient receiving 60 gm. of protein and 190 gm. of carbohydrate daily to which was added sufficient sodium chloride to maintain a normal plasma chloride concentration.

The jejunal feeding was continued for eight days postoperatively, during which time the protein intake was approximately 53 gm. and the carbohydrate 197 gm. daily. The serum protein concentration never fell below the preoperative level and was 6.9 gm. per cent at the conclusion of the feeding period. The patient thus received a daily average of about 1,000 calories, both prior to and following operation.

DISCUSSION

In any method where the oral or orojejunal route is utilized, it is important to determine, if possible, whether any condition exists where, even though all the components of tissue and serum protein are given, protein synthesis, both tissue and serum, may fail to occur. There is information to the effect that intestinal absorption may be definitely impeded in the presence of certain of the vitamin deficiencies. Calcium absorption from the intestine is retarded in the presence of a vitamin D deficiency and the fact that some hyperthyroid patients fail to gain, or even maintain, their weight, even though more than sufficient food is ingested to take care of the increased energy demands, suggests that certain of these patients may have interference with the intestinal absorbing mechanism.

Melnick and Cowgill⁹ recently have reviewed the subject of hypoproteinemia and have shown how complicated the problem may be. These authors, while admitting that the "loss and lack" theory explains many of the problems of hypoproteinemia, find that it is not compre-

hensive enough to "explain the observed facts in all instances of hypoproteinemia." They agree with Peters and co-workers,¹⁰ Bing,¹¹ and others that "some other factor, possibly injury to or an inhibition of the serum protein regenerating mechanism, must be postulated as an accessory agent."

It is a fortunate circumstance that in the type of patient discussed in this paper hypoproteinemia is essentially the result of failure of proper alimentation. It is as a rule amenable to correction through the addition of an adequate dietary. It is, however, important that the diet be satisfactory from the standpoint of its composition and also in the amount provided each day.

The average gastrostomy diet frequently will supply sufficient total calories, but generally contains considerable fat in order that the total calories be high and the bulk relatively small. The addition of much fat to the preoperative diet is, we believe, a mistake, for evidence which we have obtained in this laboratory demonstrates that with an abundance of fat in the diet the hepatic lipid concentration is increased to levels which predispose the liver to serious injury during anesthesia regardless of the presence of carbohydrate and protein in the feeding mixture.

Up to the present time we have restricted the orojejunal feeding mixture in the pre- and postoperative periods to carbohydrate, protein, sodium chloride, and certain accessory food substances. In the postoperative period fat could safely be added to increase the caloric value of the mixture. It must be remembered that following anesthetization, especially with the volatile anesthetics, bile salt production in the liver and, therefore, the amount of bile salt in the bile for a time is greatly reduced. There results, therefore, the danger that lipase activity and fat emulsification and absorption may be retarded during this period of depression of hepatic activity. Such a circumstance might result in a fatty diarrhea and lead to decreased absorption of the other components of the feeding mixture. This aspect of the problem requires further investigation.

The Abbott tube which we are now using is simple in its construction and does not depend upon the use of valves as described in the original Abbott-Rawson tube.¹² It required a few movements to pull it down into the jejunum following completion of the anastomosis. When it is used, gastric suction drainage and jejunal feeding take place simultaneously.

The feeding machine, while not necessary, is desirable. It provides for a uniform rate of feeding, with periods of rest if these are found to be desirable. It measures the amount of material which has been fed and this feature is of value in calculating the daily caloric intake. Above all, it does away with dependence on a nurse, intern, or

resident to fill the cannula holding the feeding mixture. The patient is fed whether he is awake or asleep with a minimum of discomfort and disturbance.

It is possible to use protein mixtures which have not been partially digested. We have used a partially digested protein because absorption is more readily obtained. Data which have been published recently by Rhoads, Stengel, Riegel, Cajori, and Frazier¹³ demonstrate that more amino nitrogen is absorbed from the jejunum per unit of time from this hydrolysate than is absorbed from an amino acid mixture prepared by the acid hydrolysis of casein. This, they explained, was probably due to the fact that there were available in the peptone hydrolysate larger amounts of the more readily absorbable amino acids.

It has been our experience that the early introduction of the feeding mixture into the distal jejunum results in the earlier return of peristaltic activity after operation. We have been impressed by the smoothness of the convalescence and by the fact that the patients do not request food, even though orojejunal feeding, in some instances, has been continued for as long as fourteen days after operation and the caloric intake has not been high. During this period of time, fluid and electrolyte balance, as a rule, can be maintained without resort to intravenous administration. This is of some importance for it has been our experience that phlebitis frequently occurs where prolonged intravenous therapy, especially with glucose, is maintained. The injudicious intravenous use of large amounts of sodium chloride in the postoperative period frequently precipitates edema in a patient who would not have developed this complication had nutrition been maintained and had not the water and salt intake been excessive. Too much emphasis has been placed on the fluid and salt requirements of these patients and too little on associated factors which play an important part in keeping fluids in the blood vessels.

The method need not be used in all cases for not all patients have suffered prolonged nutritional deficits. It can be used, however, in every patient subjected to a gastroenteric anastomosis where suction drainage is to be carried out after operation, for in them it simplifies the postoperative management since the nutritional requirements of the patient can be more adequately fulfilled.

SUMMARY

1. Attention has been called to some of the dietary deficiencies occurring in surgical patients.
2. The orojejunal method of feeding has been described and the advantages of this type of feeding, when there is no interference with the protein regenerating mechanism, has been pointed out.

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RESULTS OF INTRAVENOUS AND INTRA-ARTERIAL ADMINISTRATION OF FLUIDS IN TRAUMATIC SHOCK PRODUCED EXPERIMENTALLY

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IN REVIEWING the literature on shock, one is struck by the large number of methods outlined for the treatment of this condition. This fact tends to reflect, in some measure, the many hypotheses and ideas that have arisen concerning the cause of shock. As each new hypothesis has developed, the treatment has been changed in order to combat the newly suggested cause. Owing to the work of many investigators, it is a well-recognized fact that in secondary shock there is a decrease in circulating blood volume. For this reason the replacement of the lost fluid by blood or other suitable solutions has been suggested by many authors as the logical treatment of shock. The usual method of administration has been by injection into one of the superficial veins.

In the literature on shock and related subjects little work has been reported on the injection of fluids intra-arterially in these conditions. In a paper on experimental shock Davis¹ has shown that the injection of 25 per cent solution of sodium chloride intra-arterially and intravenously will produce effects that are entirely different. In the former instance the blood pressure is elevated and in the latter it is lowered. This work has been confirmed in a previous report by Kendrick and Wakim.²

In secondary shock one is dealing, not only with a decreased circulatory volume, but also with a decreased cardiac output. As a result of the work of Davis on intra-arterial injection of fluid, the question arose whether the intra-arterial injection of other solutions would elevate the blood pressure and increase the cardiac output of animals in a state of shock more effectively than the same solutions given intravenously.

Two series of experiments have been done to compare the relative value of administering fluids intravenously and intra-arterially in dogs in a state of shock produced experimentally.

METHODS

Animals weighing about 10 kg. were used in these experiments. Shock was produced by exposure and manual manipulation of the jejunum and ileum. A midline incision was made and the small intestine, from the ligament of Treitz to the ileocecal junction, was brought outside the peritoneal cavity. The same procedure was followed in each experiment and the intestine was manipulated for an equal length of time.

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The criteria used for estimating the degree of shock of the animals were hemoconcentration measurements and blood pressure readings. The concentration of the blood was determined on a Sheard-Sanford hemoglobinometer. Blood pressure taken from the femoral artery was recorded continuously through a mercury manometer on a revolving kymograph. Five per cent solution of *d*-glucose in saline solution, in quantities of 100 c.c. per kilogram of body weight, was used as the transfusion solution.

In the first series, consisting of twelve experiments, ether anesthesia was used. Anesthesia was induced in an ether chamber and maintained by autoinhalation. Only small amounts of ether were required to keep the animal anesthetized after shock had developed. The experiments were divided into two groups and, after the onset of shock, the fluid was injected intravenously in one group and intra-arterially in the other. When the intravenous route was used, the fluid was forced into the femoral vein by the gravity method at the rate of 15 c.c. per minute. When fluid was administered intra-arterially, it was injected into the femoral artery by a Woodyatt pump at a constant rate of 15 c.c. per minute.

In the second series, which consisted of four experiments, nembutal (pentobarbital sodium), 25 mg. per kilogram of body weight, was used intravenously as the anesthetic agent. When shock had developed, two of this series were given fluid intravenously and two intra-arterially.

In all the experiments hemoglobin determinations were made before and immediately after the anesthesia was started and at intervals of one hour thereafter until the subject was considered to be in a state of shock. Shock was considered to be present when the blood concentration had increased about 30 per cent. The percentage increase was based on the first specimen of blood taken in each experiment. This reading was considered normal for each subject and was arbitrarily called 100 per cent. Thus, when the hemoglobin had increased to approximately 130 per cent, the animal was considered to be in a state of shock. When the blood had reached this concentration, the blood pressure level was consistently between 75 and 85.

In order to compare the relative value of the methods of injection employed, it was necessary in all experiments to note the period required for shock to develop, the time required for the fluid to be given, and the survival time after the fluid was injected (Fig. 1).

RESULTS

In the first series of experiments, in which ether anesthesia was used, when 5 per cent solution of *d*-glucose in saline solution was injected intra-arterially, the average survival time was 2 hours and 18 minutes. When the same solution was injected intravenously, the average survival

time was 3 hours and 39 minutes. The survival time of the subjects in the second series, anesthetized with nembutal, following the intra-arterial administration of 5 per cent solution of *d*-glucose in saline solution, was 3 hours and 7 minutes; when the solution was given intravenously, the survival time was 10 hours and 30 minutes.

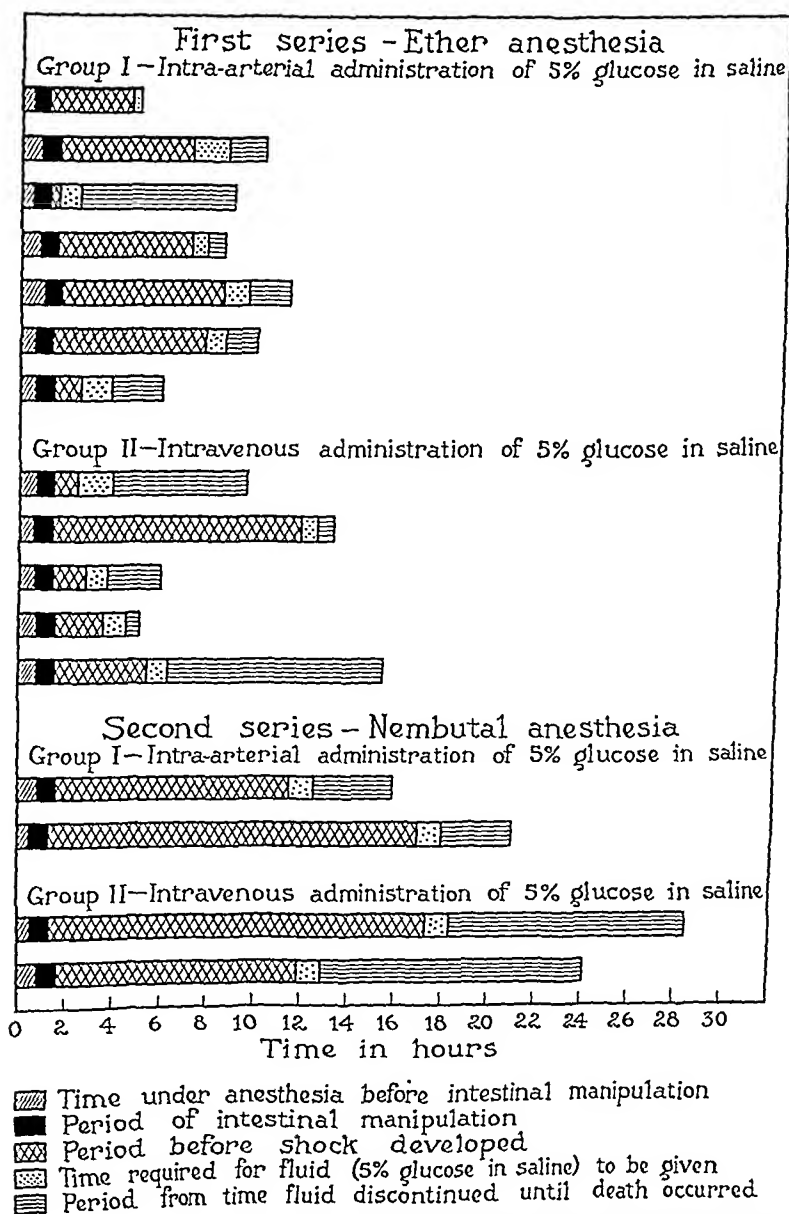


Fig. 1.—Graphic representation of the data on each series of experiments, showing the effect of administering fluids intra-arterially and intravenously in shock produced experimentally.

A comparison of the effects of the methods of anesthesia used on the rapidity with which shock developed reveals the following results. In the series in which the subjects were anesthetized with ether, the average time required for shock to develop was 3 hours and 52 minutes. In the second series, in which nembutal anesthesia was used, the average time required for shock to develop was 12 hours and 51 minutes.

COMMENT

It is interesting to observe the delay in onset of shock in dogs that have received nembutal anesthesia in comparison with those that have been anesthetized with ether. Moon³ has emphasized that the barbiturates, when used as the anesthetic, hasten the onset of shock. However, shock was produced by a different method than the one used in my experiments. He further points out that a dog anesthetized with ether will withstand much more trauma without developing shock than animals narcotized with one of the barbiturates. Seeley, Essex, and Mann,⁴ working on experimental shock, have shown that when sodium amytal is used intravenously as the anesthetic, in doses of 50 mg. per kilogram of body weight, the onset of shock is delayed an average of 7 hours longer than in similar experiments done with ether anesthesia. In my experiments the observations of Seeley, Essex, and Mann have been corroborated.

SUMMARY

A comparison has been made of the relative value of injecting 5 per cent solution of *d*-glucose in saline solution intra-arterially and intravenously in dogs in experimental shock. The results show that the intravenous route is preferable.

In the two series of experiments done, it has been shown that shock develops rather rapidly, following trauma to the intestines, when ether is used. When nembutal (pentobarbital sodium) anesthesia is used, the onset of shock is delayed several hours.

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ACUTE PERFORATED PEPTIC ULCERS

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THIS review comprises 152 cases of acute perforated peptic ulcers treated on the surgical services of the St. Louis City Hospital between July, 1932, and July, 1938. An analysis of the interesting features in the diagnosis, treatments, and results will be presented and a comparison made with other reports. All cases were on free beds and confined therefore almost exclusively to laborers and the less fortunately situated members of society, such as those on relief or the unemployed. Various nationalities were represented, but the majority were classified as Americans and all were white. In each case the diagnosis was confirmed either by operation or by post-mortem examination.

Incidence.—During the period selected for this study, there were 124,317 general admissions to the hospital, among which were 152 cases of perforated peptic ulcer, an incidence of 0.0012 per cent.

As is generally true, most of the perforations occurred in the middle years of life. There were 17.1 per cent of the patients under 30 years of age; 48.7 per cent between 30 and 50 years of age; and 34.8 per cent were over 50 years. The youngest patient was 19 years of age, and the oldest was 84 years, while the average age was 43.5 years. In Fig. 1, it can be seen that the mortality increases steadily with the age of the patient. All cases 70 years of age or over succumbed. Montgomery¹ reported an instance of a perforated ulcer in a man 75 years of age, who was operated upon and had an uneventful convalescence and subsequent good health.

Seasonal.—Much emphasis has been placed upon the seasonal occurrence of chronic gastric and duodenal ulcer symptoms. The symptoms have been thought to increase during the spring and fall months. Also, perforations have been stated to occur more frequently during these seasons. Hinton² found the frequency of perforations greater during the spring and fall months. In this series, however, the number of

TABLE I
SEASONAL VARIATION

	NUMBER	PER CENT
Fall	39	25.7
Winter	37	24.3
Spring	42	27.6
Summer	35	23.0

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cases occurring during the four seasons is approximately the same, there being only a slight increase during the spring and fall months (Table I). Since this increase is not enough to be significant, it can be concluded that in this locality the perforations are fairly evenly distributed throughout the year.

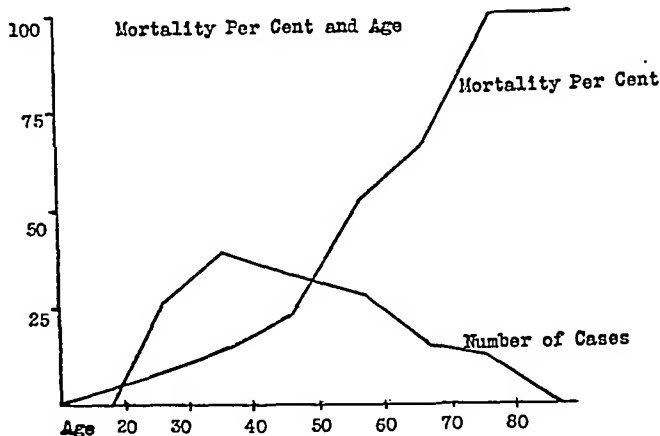


Fig. 1.

There has been little annual variation in the number of cases occurring during this six-year period (Table II). The average number of perforations yearly is 25.3. The number of deaths occurring yearly during this period varied greatly, but this depended upon so many factors that no one reason could be ascribed.

TABLE II

YEAR	NUMBER	DIED
1932	10	2
1933	25	10
1934	26	9
1935	27	8
1936	28	11
1937	25	5
1938	11	6

Sex.—There were but 7 females, representing 4.6 per cent of the cases of this series, while there were 145 males, or 95.4 per cent. This ratio of males to females compares favorably with many other reports, notably those of Urrutia,³ Dineen,⁴ Brown,⁵ Mattingly,⁶ and Sallick,⁷ indicating that men are much more prone to have perforated ulcers than women.

SYMPTOMATOLOGY

Previous History.—One hundred and twenty-eight, or 84.2 per cent, of the patients gave a history of previous gastric disturbance as indicated by the preoperative histories. The fact that 84.2 per cent of the patients, while undergoing the agony of perforation, gave this informa-

tion indicates that it is a valuable aid in diagnosis. All gradations were noted from typical ulcer histories with patients under active medical treatment to cases which gave vague gastric complaints. The duration of symptoms varied from 7 days to 55 years. Sixty-one, or 40.1 per cent, stated that they had been treated for previous gastric disturbance. There were 24, or 15.8 per cent, of the patients who experienced the pain of perforation as the initiation of their gastric disturbance. No relationship was found between the duration of ulcer symptoms before perforation and the mortality rate (Table III). It is of interest to note that there were two cases which had undergone surgical closure of a previous perforation. Pearse⁸ has reviewed the literature on recurrent perforations, examining the reports of 4,183 cases of perforated peptic ulcer, and found 33 instances of reperforation, an average of 1 in every 145 cases of perforation.

TABLE III
HISTORY OF PREVIOUS TREATMENT

DURATION	1-7 DAYS	7-30 DAYS	1-6 MO.	6-12 MO.	1-3 YR.	4-6 YR.	7-10 YR.	10 YR. OR OVER	SEV- ERAL YR.	NO DISTURB- ANCE
Number	7	22	11	6	19	17	10	20	16	24
Per cent	4.5	14.4	7.3	3.9	12.4	11.1	6.5	13.1	10.5	15.7
Died	1	5	5	1	7	4	4	9	5	10
Mortality (per cent)	14.5	22.7	45.4	16.6	36.8	23.5	40	45	31.2	41.6
Previous treatment	0	3	6	0	13	9	6	14	9	0

History of Perforation.—In ascertaining the history of the perforation, the various symptoms were evaluated to show the relative occurrence of each. These have been listed as gastric and duodenal because of the belief that chronic gastric and duodenal ulcers give typical histories. Due to the difficulty sometimes encountered in localizing lesions around the pylorus at the time of operation because of the edema and induration present, all ulcers classified as pyloric are considered in the duodenal group, and for the same reason it is justifiable to think that the symptoms are the same.

When the patient first experienced the pain of perforation, it was described as being in the epigastrium and general abdomen in 62 cases, or 40.7 per cent. The next most frequent location of the pain was in the epigastrium alone, which 52 cases, or 34.2 per cent, described. In 23 cases, or 15.1 per cent, generalized abdominal pain was described. This pain follows the escape of gastric and duodenal fluids into the free peritoneal cavity, and its extent is partly dependent upon the degree to which the peritoneal cavity is contaminated. Nevertheless, 74.9 per cent of the cases had pain in the epigastrium, indicating that it is a valuable symptom of a perforated ulcer.

In 132, or 87.4 per cent, of the cases the patient experienced a pain which was of the violently severe, knifelike type, causing the patient to "double up." The experience of this pain always remains fresh in the memory of the patient and is characteristic of a perforated ulcer. Only 11, or 7.2 per cent, of the cases had a pain described as dull; 5.4 per cent of the cases had intermittent knifelike pain; 16, or 10.5 per cent, of these latter cases had a slow onset.

Fifty-four cases were recorded as having referred pain on admission, but it is likely that many cases were not questioned about this. In Bryce's⁹ report, in which the patients were questioned specifically, a higher percentage of cases having referred pain was encountered. In one-third of our cases the pain was referred to the right shoulder and 10, or 18.8 per cent, had pain in the left shoulder. There were 9, or 16.6 per cent, who had pain in both shoulders.

Vomiting after the perforation and before operation occurred in 113, or 74.3 per cent, of the cases; while 39, or 25.6 per cent, had no vomiting. This is an unusually high percentage as compared with the reports of Eliason and Ebeling,¹⁰ Robitshek,¹¹ and Mattingly.⁶ In only 7, or 6.1 per cent, of the cases was there blood in the vomitus.

In Table IV the symptoms of perforated gastric and duodenal ulcers have been listed, and indicate that an anatomic location of the ulcer cannot be made from the history of the perforation. This shows that no time should be wasted in deciding the location of the ulcer in relation

TABLE IV
HISTORY OF PERFORATION

PAIN ANNOUNCING PERFORATION	BOTH		DUODENAL		GASTRIC	
	NO.	%	NO.	%	NO.	%
General abdomen and epigastrium	62	40.7	56	40.3	6	46.6
Epigastrium	52	34.2	48	34.5	4	30.7
General abdomen	23	15.1	21	15.8	2	15.3
Mid- and lower abdomen and right upper quadrant	15	10	14	10	1	7.6
<i>Referred pain</i>						
Right shoulder	18	33.3	16	32.6	2	40
Both shoulders	10	18.5	8	16.6	2	40
Left shoulder	9	16.6	9	18.3	0	0
Back	4	7.4	4	8.0	0	0
Lower abdomen	13	24	12	24.5	1	20
<i>Character of pain</i>						
Knifelike	133	87.5	122	87.7	11	84.6
Dull	11	7.2	11	7.9	0	0
Intermittent	8	5.3	6	4.3	2	15.3
<i>Vomiting with perforation</i>						
Vomited	113	74.3	104	74.7	9	69.2
No vomiting	39	25.7	35	25.3	4	30.8
Vomited blood	7	4.6	4	2.8	3	23

to the pylorus, but emphasis should be concentrated upon establishing the diagnosis of the perforation.

Physical Findings.—Practically all of the patients on admission appeared to be in acute distress and suffering. Three of the patients were moribund at the time they were first seen and died soon afterwards. The great variability of the abdominal signs on admission can be explained on the basis of the time intervals allowed to elapse after the perforation. In 14 cases generalized abdominal tenderness and rigidity were present. In 117 cases there was generalized abdominal tenderness and rigidity in which the area of maximum localization was stated. In 76 of these 117 cases the tenderness was most marked in the epigastrium, 23 cases in the right upper quadrant, 9 cases in the right lower quadrant, and 9 cases in the left upper quadrant. In 13 cases tenderness was confined to the epigastrium and in 4 cases to the right upper quadrant. Twelve cases were recorded as having fluid in the flanks. Obliteration of hepatic dullness was noted in only 7 cases. In 1 case there were no localizing signs.

TABLE V
PHYSICAL SIGNS

	BOTH		DUODENAL		GASTRIC	
	NO.	%	NO.	%	NO.	%
General tenderness and rigidity	14	9.2	12	8.8	2	16.6
General tenderness and rigidity with tenderness most marked in:	117	76.9	107	78.6	10	83.3
Epigastrium	76	51.2	69	50.7	7	58.3
Right upper quadrant	23	15.4	21	15.4	2	16.6
Right lower quadrant	9	6.0	9	6.5	0	0
Left upper quadrant	9	6.0	8	5.8	1	8.3
Tenderness in epigastrium	13	8.5	13	9.5	0	0
Tenderness in right upper quadrant	4	2.6	4	2.9	0	0

In the usual description of a perforation, the patient is said to be in a state of shock immediately after the catastrophe occurs. This condition is not true shock. Although the temperature may be subnormal, the pulse will not be fast (usually below 100) and the blood pressure will be within normal limits. After this comes the stage of reaction in which the intensity of the pain subsides and the temperature and pulse are normal. This is then followed by peritonitis. Thus, the clinical findings at the time of admission showed marked variation, depending upon the stage of the illness and the physical condition of the patient.

In 149 cases in which the temperature was recorded on admission, it was found that 79.4 per cent had a temperature between 97 and 100°. The lowest temperature recorded was 96° and the highest 102.4°, while the average was 98.8°. The average pulse rate was 96 per minute, the minimum being 60 and the maximum 160. The average respiratory rate was 22 per minute, while 18 was the minimum and 38 the maximum.

Laboratory Findings.—In 146 cases the leucocyte count was taken. The average was 14,067; the lowest count was 3,000 and the highest 38,000. There were 5 patients with a leucocyte count below 5,000 and all of these died. Only 4 cases had a count over 30,000 and 1 of these died.

Roentgenography has been used as an adjuvant in establishing the diagnosis of a perforated peptic ulcer by the demonstration of a pneumoperitoneum. Vaughan and Singer¹² in 1929 reported this as a means of definitely establishing the diagnosis and reported 72 cases in which a pneumoperitoneum was demonstrated in 63. In this series 132 cases had films taken in the sitting-up position and a pneumoperitoneum was demonstrated in 91, or 68.9 per cent, while 41, or 31.1 per cent, had no air under the diaphragm. This procedure is very valuable in cases in which the diagnosis is doubtful and to rule out important nonoperative and medical lesions; nevertheless, the absence of a pneumoperitoneum should not be conclusive that a perforated ulcer is not present. In one instance an ulcer perforated while the patient was receiving a gastrointestinal x-ray examination, and the diagnosis was made immediately.

Preoperative Diagnosis.—Table VI lists the preoperative diagnoses as made in the admitting room or soon after entry to the hospital. In 83.5 per cent of the cases a correct diagnosis was made. In considering the diagnoses, 94.7 per cent were recognized as acute surgical emergencies requiring immediate operation. Acute appendicitis was the most frequent mistaken diagnosis and acute cholecystitis next. Acute pancreatitis and intestinal obstruction were other mistaken diagnoses.

TABLE VI

Perforated peptic ulcer	127
Perforated viscus, type undetermined	6
Acute appendicitis	4
Acute cholecystitis, intestinal obstruction, etc.	15

Mortality in Relation to Time of Perforation.—The length of time that elapsed between the onset of the attack and the operation varied greatly. It is universally recognized that an acute perforation constitutes a surgical emergency and delay in operation increases the mortality rate. In this series 140 cases were operated upon and Fig. 2 shows the time from the onset of perforation until the patient was operated upon. It is seen that the mortality increases steadily with delay in operation. An exception to this is the slight fall in death rate in those patients in which a delay of from forty-eight to seventy-two hours had occurred.

In these few cases there was a tendency to walling-off of the perforation and, although operated upon late, there was less peritoneal involvement and the patient's physical condition was better. In 106 cases operated upon within the first twelve hours, the mortality rate was 19.8 per cent.

Location of Perforations.—The large majority of perforations occurred in the anterior surface of the stomach and duodenum within 1 inch to 1½ inches of the pyloric vein. They were, for the most part, the characteristic type, being round, single, resembling a punched-out hole or opening, with the base of the ulcer being very indurated. The size of the perforations varied from 1 to 20 mm., the average being 5.5 mm. There was no correlation between the size of the perforation and the duration between perforation and operation. The majority of the larger perforations were found to be in patients who gave histories of ulcer symptoms of long standing. In 77 cases the perforations were in the duodenum and in 62 cases in the prepyloric area. The perforations described as prepyloric constitute those that are immediately proximal to the pyloric vein. Only 13 gastric perforations were found away from the pylorus. Three of these ulcers were at the cardiac end and 2 on the posterior surface of the stomach. In these cases the histories and physical findings were no different from the cases of duodenal perforations. There were 2 cases in which the ulcers were proved to be malignant. The mortality for duodenal ulcers was 31.6 per cent and for gastric ulcers, 53.8 per cent.

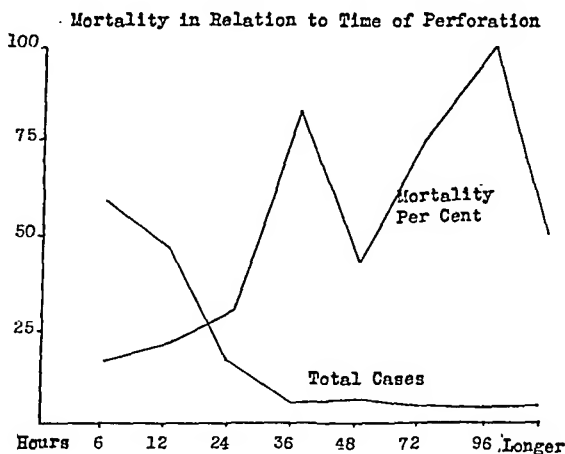


Fig. 2.

Treatment.—It is our belief that the simplest and quickest operation should be performed in acute perforations, and the operation of choice is simple closure by a purse-string and in a great many cases a tab of omentum was sutured over the closure. This procedure is used with the view in mind of preserving the life of the patient and seems to be fraught with the least mortality. The operations of gastroenterostomy, pyloroplasty, and gastric resection were performed infrequently or were reserved for a later date when conditions were more favorable. Later it will be shown that only a small percentage of cases

necessitated secondary operations, thus justifying the procedure. The majority of operations were performed by the resident surgeon, who changes yearly, so that a number of surgeons did the 140 operations. One hundred and twenty-four, or 81.5 per cent, had a simple closure of the perforation and only 3 patients had a simple closure with a gastroenterostomy. The percentage of mortality for simple closure was 25.8 and for pyloroplasty 25. The other types of operation had a much higher death rate. Pyloroplasty was reserved for ulcers in which there was a tendency toward walling-off and thus performed under more favorable circumstances than simple closure. Table VII shows the types of operations performed.

TABLE VII
TYPES OF OPERATION

	NO.	%	DIED	%
Simple closure	124	81.5	30	25.8
Pyloroplasty	4	2.8	1	25
Closure and posterior gastroenterostomy	3	1.9	2	66.6
Simple closure and appendectomy	2	1.3	0	0
Multiple drains only	2	1.3	2	100
Other procedures	5	3.4	4	80

Whether or not to drain the abdominal cavity has always been a subject of contention. Of 140 operated cases, 102 were drained, while 38 were not, and the mortality rate was practically the same in each group. Drainage was generally used where the perforation was of long duration or where the leakage excessive. A stab wound in the right flank was the choice site of drainage.

TABLE VIII

	NUMBER	DIED	PER CENT
With drainage	102	28	27.4
Without drainage	38	11	28.9

Spinal anesthesia (novocain crystals) was the anesthetic of choice. In 101 cases a spinal anesthetic was given and in 20 of these supplementary gas-ether was used. Thirty-one cases were given a general anesthetic. Local anesthesia was used in 8 cases in which the patients were considered poor operative risks. No deaths were due to the anesthetic.

If one excludes peritonitis, since all cases of perforation have a soiled peritoneum, pulmonary disease constitutes the largest group of complications. There were 24 pulmonary complications with a mortality rate of 37.5 per cent. Pneumonia, including lobar pneumonia and bronchopneumonia, constitutes 54 per cent of the pulmonary complications. There were 4 cases of atelectasis and 3 cases of pulmonary edema. The other complications include lung abscess, hydrothorax, and laryngeal edema. Fifty, or 37 per cent, had wound infections. A

wound was considered infected if the skin edges were separated and pus was present. This would probably indicate that more of the drains should have been brought out through stab wounds in the flanks or the wounds should have been drained down to the peritoneum. In 6 cases the wounds disrupted. Other complications include duodenal fistula and subphrenic abscess, with 4 cases each. Four patients had delirium tremens, 1 of whom died. Only 1 case developed a parotitis and only 1 case had a pelvic abscess as a complication.

Drainage of the stomach by use of nasal tube was used postoperatively in 76 cases, or 54.3 per cent, for an average of 4.3 days. It was used with increasing frequency during the last three years.

Results.—The mortality rate for the 140 operated cases was 39, or 27.8 per cent. There were 12 patients not operated upon and a post-mortem examination was made on all of these cases. In considering the nonoperated cases, there were 3 over 71 years of age who were in a moribund state upon entry and who died soon afterwards. Four cases were in extremely poor physical condition on entry and supportive measures were instituted, but the patients did not rally enough to consider operating. In one patient who died shortly after admission, the diagnosis was not made until post-mortem examination. There were 4 cases in which an incorrect diagnosis was made.

The average stay in the hospital for the patients who recovered was 25.1 days. The minimum number of days was 11 and the maximum 130 days. Fifty-one per cent of the postoperative deaths occurred within the first three days.

A follow-up was made on 57, or 56.4 per cent, of the 101 patients discharged. A patient was considered as having a good result if he had been entirely free from pain and had been able to work. A few of these patients remain on a diet. If the patient at times had pain which was easily controlled by a diet, it was considered a fair result. The patients who continued to have ulcer symptoms all the time were considered a poor result. By these standards, 43, or 75.4 per cent, were considered as having a good result; 10 cases, or 17.5 per cent, a fair result; and 4 cases, or 7 per cent, a poor result. According to Bryce,⁹ any return in symptoms after a simple closure will take place within two years. He found in 48 patients in whom recurrence of symptoms took place and who stated the period of respite that in only 4 cases was it longer than one year and nine months. Table IX shows the length of time that our patients have been observed after the perforation. All patients with a fair or poor result with two exceptions had ulcer histories of long-standing duration, the average duration of symptoms being 6.5 years. Several of these patients were given a barium meal, most of them showing a constant nontender deformity of the duodenal bulb which may have been the result of surgery. One patient had a severe gastric hemorrhage several months

after operation but is now on a diet and in good health. One patient had a subsequent gastroenterostomy with good results and another had a partial gastrectomy and died during the postoperative period.

TABLE IX

YEAR	1932	1933	1934	1935	1936	1937	1938	TOTAL	%
Good	0	7	3	8	10	12	3	43	75.4
Fair	1	2	1	2	2	1	1	10	17.5
Poor	0	0	1	1	1	1	0	4	7.0

COMMENTS

Men are more prone to have perforated ulcers than women, but no satisfactory explanation for this can be made.

Perforations occur more frequently during the middle years of life and the mortality increases with the age of the patient. All cases 70 years of age or over died.

In this locality there is practically no seasonal variation in the number of perforations. The number of cases occurring each year is practically the same.

The majority of perforations have antecedent histories of gastric disturbance and the physical findings are fairly constant, thus enabling an early diagnosis. Roentgenography is an aid in establishing the diagnosis in doubtful cases. It has been shown that most cases can be diagnosed early and thus surgical intervention hastened.

The operative procedure employed is primarily directed at closing the source of contamination. In this series a simple closure was used with good results. Other men, notably Deaver,¹³ Alexander,¹⁴ and Mills,¹⁵ use gastroenterostomy along with simple closure in early cases, but the results are not entirely satisfactory, since some of the patients were not entirely relieved of the symptoms. Pyloroplasty has been advocated by some men with varying results. Hinton² stated in his report that the results did not seem to justify the procedure. Gastric resection is the generally accepted procedure in Europe as emphasized by Graves¹⁶ in his analysis of 4,402 cases from their clinics. In Europe multiple gastric and duodenal ulcers occur in an average of 30 per cent of the patients operated upon for acute perforations and, if the so-called ulcer-bearing area is not removed, there is a fairly high percentage of recurrence of symptoms due to the presence of remaining ulcers. This has not been our experience. The procedures other than simple closure are used to cure the ulcer and such operations performed under more favorable circumstances carry a mortality in themselves. Loehr¹⁷ states that in 90 per cent of perforations of the duodenum and in 82 per cent of perforations of the stomach, the gastric contents are sterile and the number of organisms in any particular instance is controlled by the acidity of the gastric juice. Thus, one

can never be sure that the peritoneum is not contaminated in even an early case. Moreover, with only 7 per cent having poor results, it seems reasonable to delay additional operative procedures until a later date, when they can be performed when indicated.

The follow-up study gave conclusion that simple closure is an effective method of treatment. The persistence of ulcer symptoms after surgical closure of a perforation may be due to the existence of more than one ulcer, one of which perforated and was repaired surgically and the other left untouched. A chronic ulcer on the posterior surface of the stomach or duodenum easily could be overlooked if a perforated ulcer is present on the anterior surface. This fact is substantiated by two of our cases operated upon, each of which was found to have two ulcers, only one having perforated. Another case had two ulcers perforate simultaneously. The cases that have persistence of ulcer symptoms after a simple closure in which a reasonable period has elapsed after the institution of the proper dietary regime should have some type of radical surgery which is primarily directed at a cure.

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EXPERIMENTAL OSTEOMYELITIS: THE EFFECTS ON RIBS OF INCREASED INTRAMEDULLARY PRESSURE AND OF TOXIN- AND NONTOXIN-PRODUCING STRAINS OF STAPHYLOCOCCI

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AN INTERESTING method for producing an increase in the intramedullary pressure in long bones was described recently by Larsen.¹ This consisted, in brief, of making an incision in the periosteum of the femur and of perforating the cortex with a drill. A flanged cannula was then screwed into this opening and the cannula was connected to a Kelly bottle which contained sterile salt solution. In this manner pressures of any desired degree could be transmitted to the medullary cavity. The main disadvantage of this method of study would appear to be that evidences of infection appeared in most of the experiments. Another possible disadvantage lies in the necessity for making a rather large opening by a drill hole in the bone.

It occurred to us that these features might be obviated and that the effects of pressure and of infection might be separated by substituting for the cannula a needle which was introduced into the medullary cavity of bone through an adjacent cartilage. In this manner neither the periosteum nor the cortex of the bone would be injured and the chances of infection would be lessened. For these purposes, it seemed that the anterior portions of the ribs with the attached cartilages would be of advantage in that the ribs are very superficial and their multiplicity would allow a number of studies on the same animal. For example, the effects of increased intramedullary pressure alone, of bacteria alone, and of the combination of the two might be studied in different ribs on the same animal. The chief disadvantage of this method of study would seem to reside in the fact that osteomyelitis of ribs is rare in the human. It is the purpose of the present paper to report the results of these studies.

METHODS

Dogs were used in all studies. Elevated intramedullary pressure was produced by the injection of 0.9 per cent saline solution at various pressures through a needle which was inserted obliquely into the costal cartilage and across the costochondral junction into the medullary canal of the tip of the rib. The experiments may be divided into five groups.

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Group I included studies on ribs during and immediately after increased intramedullary pressure maintained for periods up to twenty-four hours. In Group II, following a period of elevated intramedullary pressure, the animals were allowed to recover and the ribs were studied after varying intervals. Group III included the studies on ribs in which cultures of staphylococci were injected through a needle into the medullary canal near the tip of the rib. In Group IV a period of elevated intramedullary pressure was followed by the injection of a culture of staphylococci through the needle. Group V included experiments in which, following elevated intramedullary pressure by the injection of salt solution, organisms were injected intravenously. After sacrificing the animal, the ribs were removed, x-rayed, sectioned, and examined both grossly and microscopically. By the use of several ribs in the same dog for different types of experiment, results could be compared in the same animal.

Animals were anesthetized by nembital given intravenously (25 mg. per kilogram). Using aseptic precautions, a small incision was made over a selected costochondral junction and the muscles were separated, thus exposing the tip of the rib and costal cartilage. A No. 20 gauge spinal needle with stylet in place was pushed into the cartilage, beginning at a point about 5 mm. back from the costochondral junction, aimed in the longitudinal axis of the rib at such an angle as to pass across the costochondral junction into the center of the medullary canal, and down the canal for a distance of 5 to 10 mm. The incision was closed tightly in layers about the needle with fine black silk. A reservoir of sterile 0.9 per cent saline solution was connected to the needle, placed at the desired height to give various hydrostatic pressures, and maintained at that level for varying periods of time, from sixteen to thirty-three hours. Additional nembital and morphine were given as required during the course of the experiment to keep the animals free of pain.

The organisms used were eighteen-hour broth cultures of staphylococci supplied by Dr. R. H. Rigdon, of the Department of Pathology. Strain 7 is a nontoxin-producing *Staphylococcus aureus*; Strain AO produces a potent exotoxin, capable of producing marked tissue necrosis as demonstrated by Rigdon.² Both strains have been maintained for several years at a fairly constant level of virulence by culture on artificial media.

RESULTS

Group I. The Immediate Effects of Elevated Intramedullary Pressure Produced by the Injection of Saline Solution.—The immediate effects of elevated intramedullary pressure have been studied on twenty ribs of seven pups and eleven ribs of four adult dogs. In some of these experiments the wounds were left open and coloring material added to the saline solution, so that its course might be followed. Immediately after beginning the injection at pressures of 100 to 200 cm. of saline solution,

blood in the intercostal vessels was seen to be displaced by saline solution. Within one to two minutes, dye appeared in the cortex of the rib overlying the point of the needle, coloring the 1 or 2 cm. next to the cartilage. In the course of several hours the amount of color in the bone increased and spread to the periosteum overlying the stained portion of the rib. In six to twelve hours edema and hyperemia of the periosteum were noted, both in pups and adult dogs. At the end of sixteen to twenty-four hours, in two-thirds of the pups and one-third of the adult dogs the periosteum was found to be separated from the rib by salt solution. This separation in some instances included the whole circumference of the rib. More often the periosteum was separated on only a portion of the circumference, in which case it was usually the pleural surface which was stripped. The stripping extended longitudinally from the costochondral junction for a variable distance, usually 2 to 4 cm., but in some experiments extended back almost to the vertebral end. The amount of periosteal stripping was not dependent upon the amount of saline solution infused. Stripping occurred in pups with amounts of salt solution as small as 20 c.c. or as great as 700 c.c. The actual amount of saline solution infused probably depended upon the relation of the point of the needle to vascular spaces, or spicules of bone. As stated, periosteal stripping occurred more frequently and apparently more easily in pups than in adults. It has been noted in pups that the periosteum is thicker, more vascular, and more readily separated from the bone by other mechanical means. The combined layer of periosteum and pleura dissected up on the pleural surface of the rib by the saline solution occasionally ruptured and allowed saline solution to fill the pleural cavity. This occurred in four of the pups used in these experiments, with pressures of 130 to 225 cm. of saline solution. Periosteum has been found to be stripped in pups at a pressure of 91 cm., this being the lowest pressure tried. The bone from which periosteum had been stripped had a slightly rough, dull appearance, and, with continued pressure in the medullary canal, fluid came through the cortex in tiny beads in the ribs of pups. In adults the openings in the cortex where the periosteal vessels had been torn off were larger and fluid ran through more freely.

The injected salt solution did not flow freely down the medullary canal. If, while it was being injected, the rib was cut across near the vertebral end, no solution flowed from the medullary canal. If only 3 to 4 cm. of marrow intervened between the needle and the open end of the rib, saline solution then ran from the cut end.

In order to try to determine whether the separation of the periosteum was a mechanical process or a reaction of the living periosteum, similar experiments were done after death of the animal. In ribs in which elevated intramedullary pressure was produced by the injection of salt solution, beginning immediately after the animal's death, edema and

separation of the periosteum occurred with the same pressure and after the same time interval as in the living animal.

Group II. The Later Effects of Elevated Intramedullary Pressure.—In a total of ten ribs of ten pups, pressures of from 104 to 225 cm. saline solution for sixteen to thirty-three hours gave essentially the same response. After two days it was found in one rib that the thickened, red periosteum about the tip of the rib was detached for 2.5 cm., separated from the rib by a reddish thick exudate containing many polymorphonuclear cells on smear, but no organisms. The bare bone was lusterless and finely pitted, with a brown necrotic marrow in its distal 3 cm. In another rib, ten days after increased pressure, the periosteum was thickened, with an underlying zone of soft granulation tissue from which the

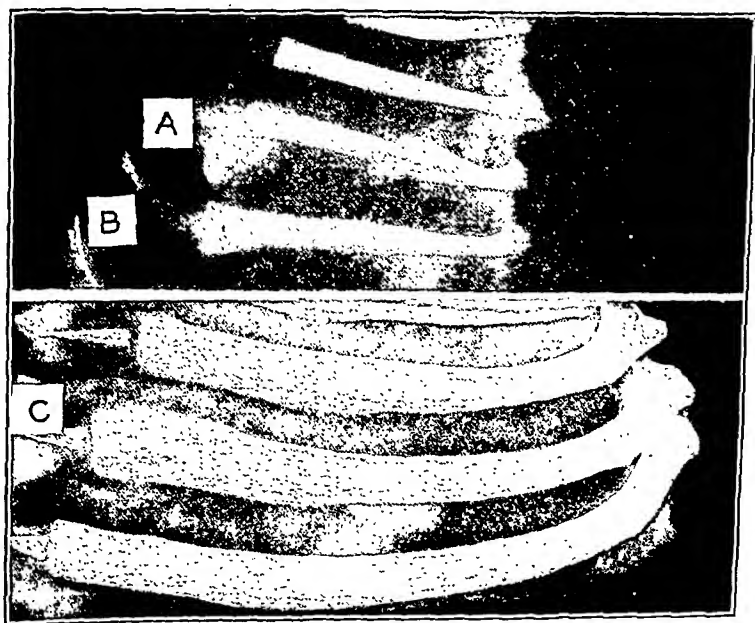


Fig. 1.—X-rays of ribs. A, Pup rib twenty-three days after elevated intramedullary pressure of 156 cm. for seventeen hours, followed by 1 c.c. of a culture of toxin-producing *Staphylococcus aureus*. Destruction of the rib at the tip with dislocation of the costochondral junction is seen. The destruction and new bone formation in the middle third of the rib is unusual, being limited usually to the tip. B, Pup rib twenty-nine days after elevated intramedullary pressure of 156 cm. of saline solution for ten hours. New bone is present about the tip of the rib. C, Adult rib thirteen days after the injection of 0.25 c.c. of toxin-producing staphylococcus culture into the rib. Destruction of areas of bone but little or no deposition of new bone has occurred.

rib could be rather easily peeled out. The rib was porous and brittle, sections showing necrosis of the marrow and cortical bone. Eight ribs of pups examined after ten to twenty-nine days demonstrated a fairly uniform picture. A layer of firmly attached periosteal new bone surrounded the rib, with new bone widening the costochondral junction. The marrow was brownish yellow in color. X-ray films demonstrated the shell of new bone about the rib and widening of the junction with the

cartilage (Fig. 1 *B*). In all cases the new bone was tightly adherent to the rib, without sequestration. In sections through these ribs there was necrosis of the marrow cells and a replacement by fibrous tissue. Variable amounts of cortical and medullary bone were necrotic as judged by absence of cells in the lacunae and altered staining reaction of the bone. The periosteum was thickened, with new bone laid down about the old cortex and larger amounts of bone about the costochondral junction (Fig. 2).

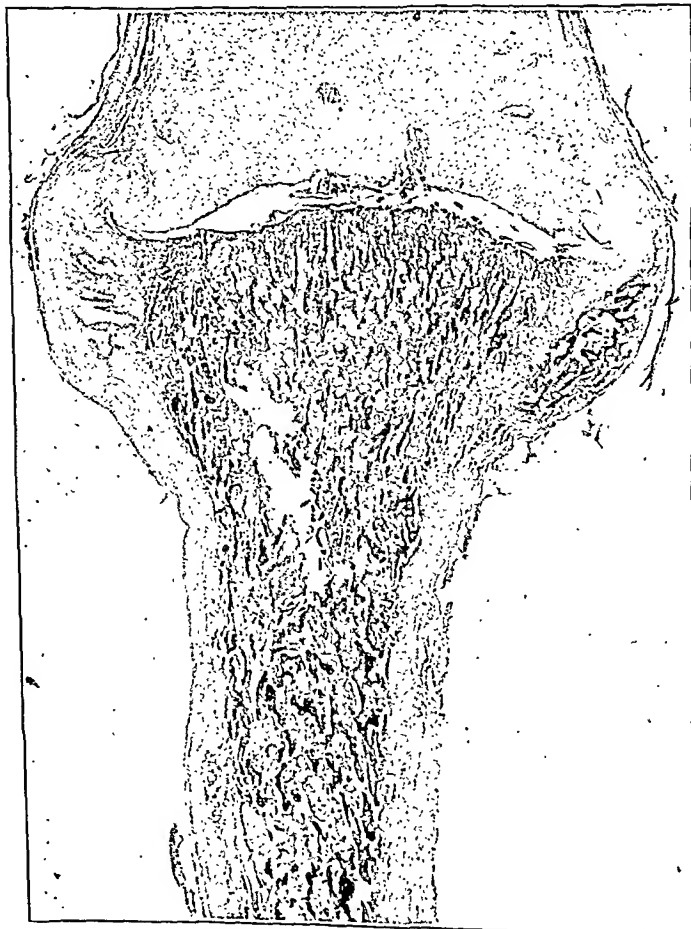


FIG. 2.—Section of puppy rib fourteen days after elevated intramedullary pressure of 225 cm. of saline solution for eighteen hours. There is replacement of marrow cells by fibrous tissue and fat, necrosis of medullary and cortical bone, with new bone in the adherent periosteum. ($\times 16$.)

In the eight ribs of the adult dogs similar changes of lesser grade were seen; in some, the bone necrosis and new bone formation were so slight as to be negligible.

Group III: The Effects of Injection of Organisms Into the Medullary Canal.—As stated before, broth cultures of staphylococci were injected

into the medullary canal of ribs, close to the costochondral junction, through a needle inserted as described.

In eight ribs of four pups 0.25 to 2.0 c.c. of an eighteen-hour broth culture of Strain 7 (nontoxin-producing) *Staphylococcus aureus* was injected, and the ribs studied after seventeen to forty-two days. No change could be detected in these ribs, and the organisms caused no other lesions in the animals.

In fourteen ribs of eight pups 0.2 to 1.0 c.c. of an eighteen-hour broth culture of Strain AO (toxin-producing) *Staphylococcus aureus* was injected. Six of the pups died in from one to seven days, exhibiting focal necrosis and hemorrhages in the kidneys and mucosal hemorrhages in the colon. One pup dying after twenty-four hours showed no gross changes in the rib. In those dying after two to seven days there were edema and necrosis of the muscle tissue overlying the rib and separation of the costochondral junction. The periosteum was red and edematous for 2 to 4 cm. and separated from the rib for a few millimeters at the costochondral junction, but it usually was not stripped further than this. However, it could be easily removed. The marrow was moist and soft and the tip of the rib appeared porous and necrotic. Microscopic examination of these ribs four to six days after injection demonstrated an area of acute necrosis of the marrow tissue, only a few pyknotic nuclei remaining in a mass of debris. There was destruction and absorption of the columns of ossifying cartilage, so that a line of separation was formed between the costal cartilage and the tip of the rib. The necrosis present in the marrow extended through the Haversian canals of the cortex to involve the periosteum. The necrosis and inflammatory process extended outside the cortex along the periosteum (Fig. 3).

The ribs of pups surviving longer after the injection of organisms showed evidences of repair, with absorption of necrotic bone and deposition of new bone. After ten days, as seen in one rib on x-ray examination, there was a moth-eaten appearance of the tip of the rib, which was surrounded by a thin shell of new bone. Grossly, the end of the rib was enlarged and hyperemic, the marrow soft, brown, and necrotic, with a layer of new bone about the cortex. Microscopic sections showed much new bone about the medullary canal, with very little remnant of the old cortex at the tip of the rib and a collection of leucocytes in the medulla near the costal cartilage. The columns of ossifying cartilage were completely absent. After twenty-five days, there was further deposition of bone about the tip of the rib, ossification along the costochondral junction occurring from its periphery, the center being occupied by gelatinous granulation tissue.

Organisms of the AO strain (toxin-producing) were injected into a total of six ribs in five adult dogs, 0.25 to 0.5 c.c. being injected. None of the dogs died following injection of the organisms, and but one wound broke down and drained. These ribs were examined after thirteen to

thirty-nine days, less change being seen than in the ribs of pups. On x-ray examination, a slight to moderate absorption of bone in or close to the tip of the rib was seen, with decreased bone density in areas and only a small amount of new bone about the tip of the rib (Fig. 1 C). On gross section, the marrow close to the rib tip was brown, with small amounts of grayish soft tissue in the junction of rib and cartilage and a very thin zone of periosteal new bone. The microscopic appearance was similar to that seen in pup ribs.

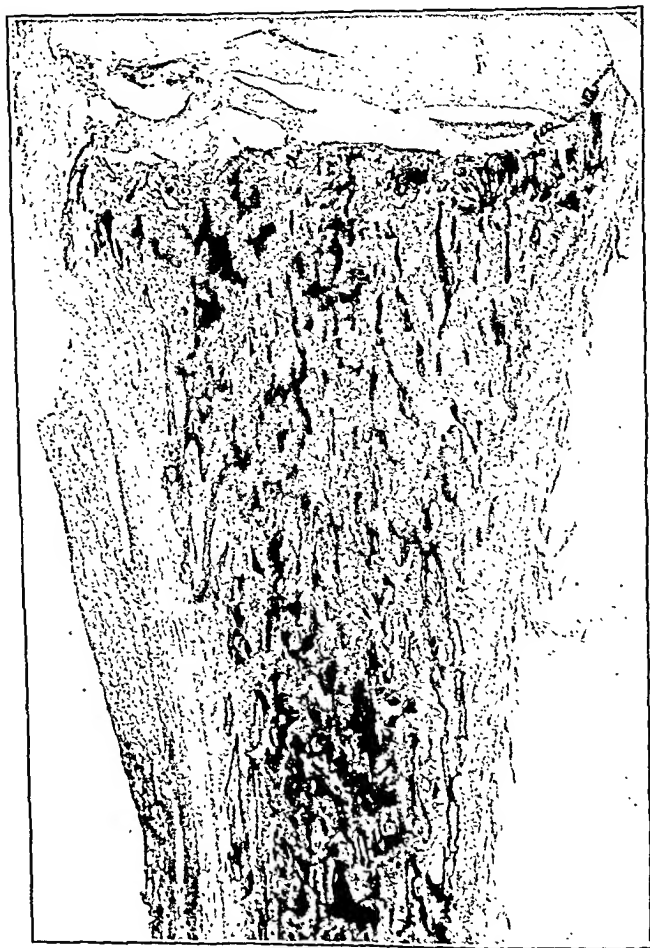


Fig. 3.—Section of puppy rib four days after injection of 0.25 c.c. of a culture of toxin-producing staphylococcus. There is necrosis of the marrow and absorption of the columns of ossifying cartilage, leading to separation of the costochondral junction. The necrosis extends through the cortex to involve the periosteum. ($\times 24$.)

Group IV. The Effects of Increased Intramedullary Pressure With Infection.—In view of the periosteal bone formation without sequestration in response to increased intramedullary pressure alone, the effect of injecting organisms into the rib after saline pressure had been exerted in the medullary canal for some hours was studied. Saline pres-

sure of 156 cm. was used throughout these experiments, exerted for sixteen to twenty hours. Immediately after disconnecting the pressure bottle from the needle, organisms were injected and the needle removed. One rib of each of four pups was studied after 156 cm. pressure had been exerted for sixteen to eighteen hours followed by the injection of 0.5 to 1.0 c.c. of AO (toxin-producing) staphylococcus. In one pup

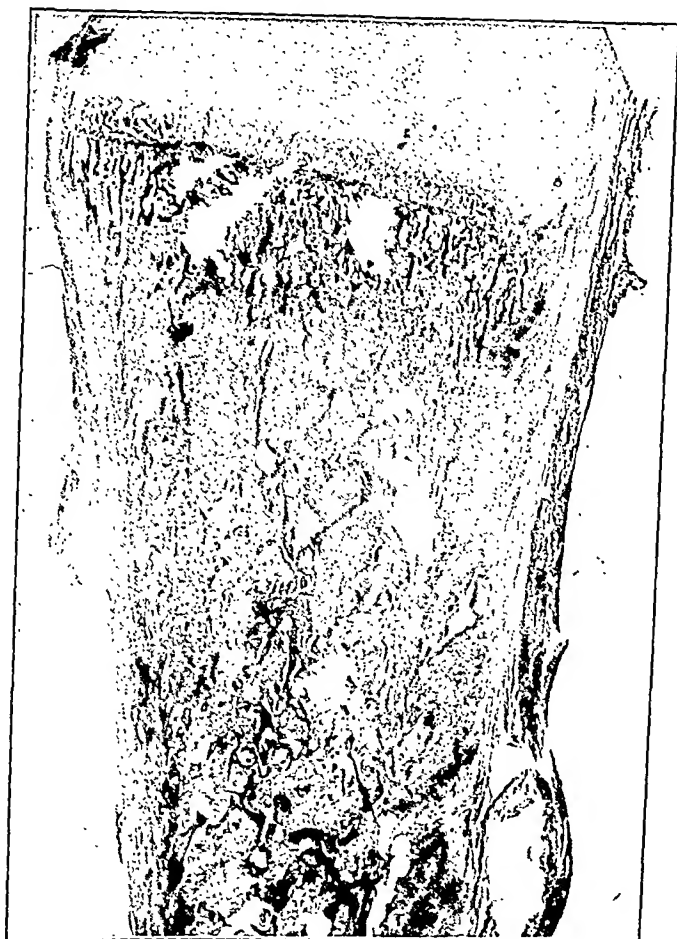


Fig. 4.—Section of adult rib two days after increased intramedullary pressure of 156 cm. for eighteen hours, followed by 1 c.c. of toxin-producing staphylococcus culture. Necrosis of marrow, cortex, and overlying periosteum is present, with infiltration of the periosteum by leucocytes beyond the areas of acute necrosis. ($\times 16$.)

dying after two days, red, thickened periosteum was detached from the rib on the pleural surface for 4 to 5 cm. from the costochondral junction, and the costochondral junction was separated. Microscopic section demonstrated an acute necrosis of the marrow tissue, absorption of the columns of ossifying cartilage, producing a separation of bone and cartilage, and an acute inflammatory reaction in the periosteum which

was detached from the cortex. After eighteen and twenty-three days, x-ray examination demonstrated a spotty moth-eaten appearance, usually of the distal 2 to 3 cm. of the rib and a thick shell of new bone about it (Fig. 1 A). After forty-three days, a thick shell of involucrum was present with apparently complete resorption of the old cortex near the tip of the rib. In sections of these ribs there was a very ir-

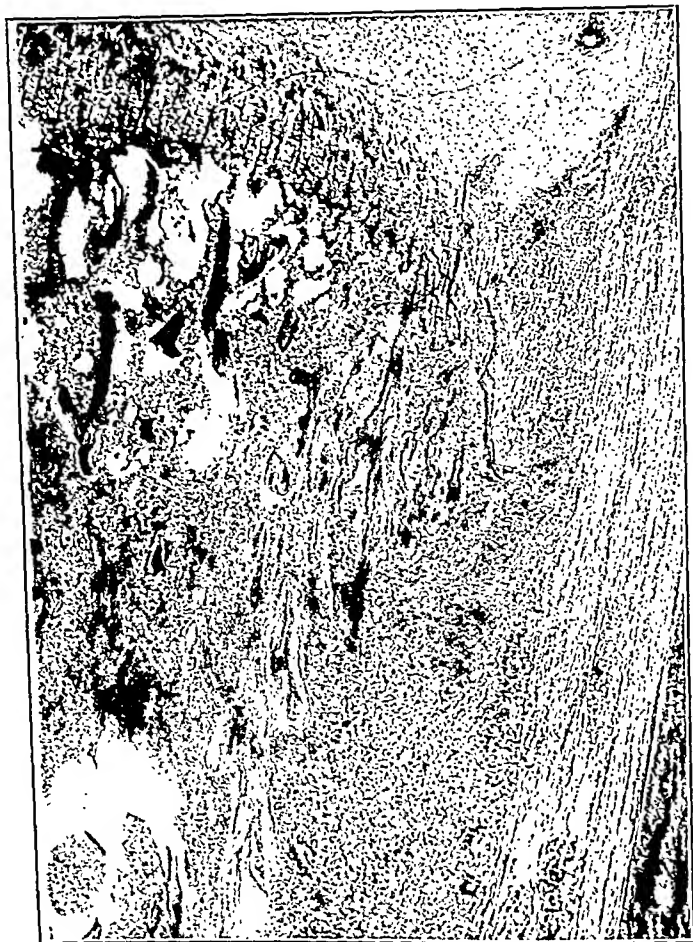


Fig. 5.—Portion of Fig. 4. ($\times 48$.)

regular and widened line of ossification at the cartilage and formation of new periosteal bone. The cortex and cancellous bone were necrotic, as was the marrow near the tip of the rib. The necrotic bone in places was separated by granulation tissue from involucrum, but in others it was intimately attached to periosteum in which new bone was being deposited along the necrotic cortex.

Three pups received 0.5 to 1.0 c.c. of broth culture of Strain 7 (non-toxin-producing) staphylococcus following a similar period of elevated

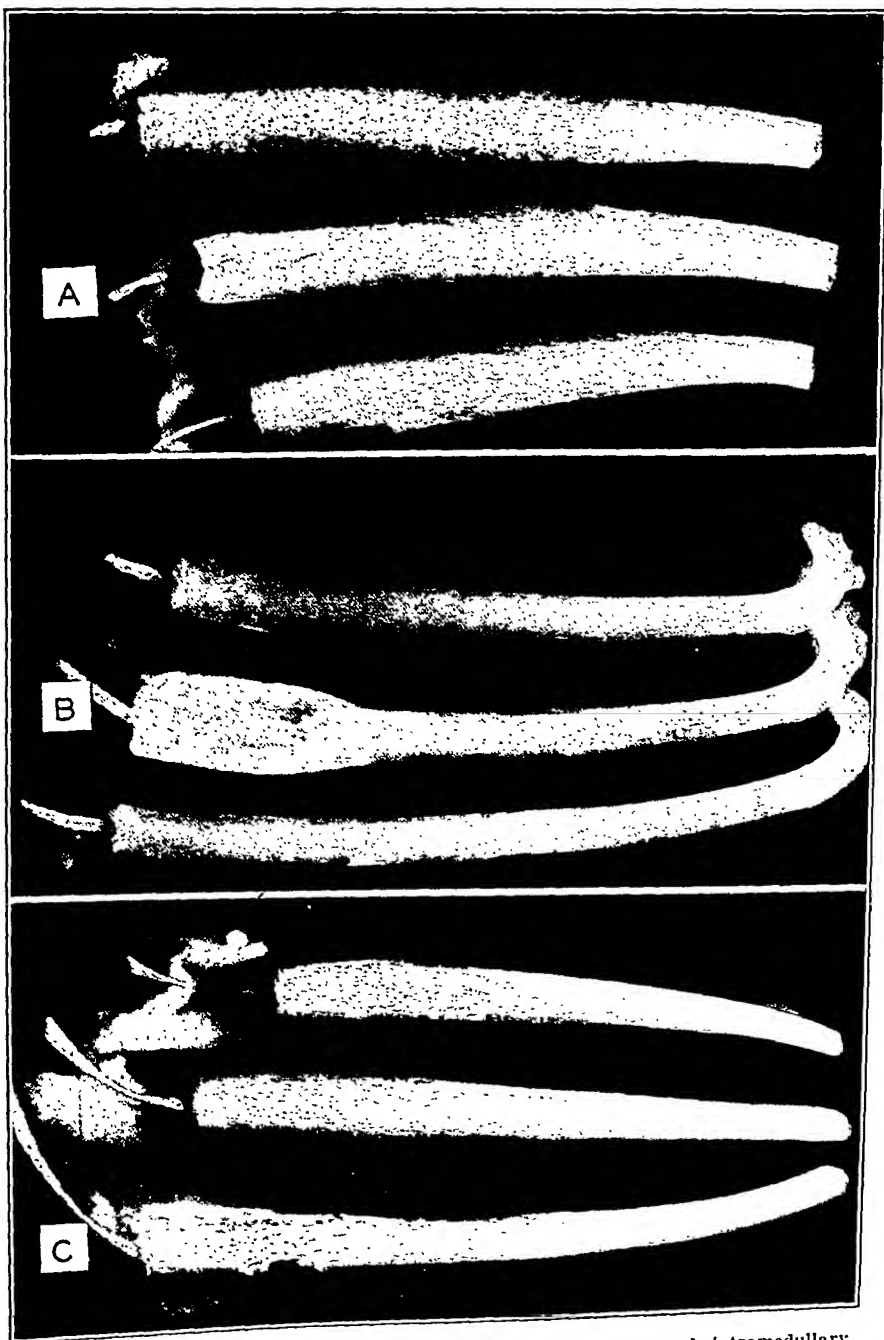


Fig. 6.—A, X-ray of adult ribs forty-one days after increased intramedullary pressure followed by 1 c.c. of nontoxin-producing staphylococcus culture. There is a small area of rarefaction, surrounded by bone of increased density. B, X-ray of the same rib as shown in Fig. 7 to show the bone destruction, involucrum, and sequestration. C, X-ray of adult rib nineteen days after elevated intramedullary pressure followed by the intravenous injection of toxin-producing staphylococci. The amount of bone destruction and new bone formation is evident.

intramedullary pressure. When sacrificed after twenty-four to forty-one days, these ribs showed some increase in density and thickness of the cortex. There was irregularity of the costochondral junction, such as was seen with pressure alone, but without the bone destruction occurring after toxin-producing organisms.



Fig. 7.—Cross section of adult rib twenty-seven days after elevated intramedullary pressure followed by injection of toxin-producing organisms. The large amount of new bone and a small bit of free, sequestered bone are shown. ($\times 17$.)

Increased intramedullary pressure of 156 cm. of saline solution maintained for sixteen to twenty hours was followed by 0.25 to 1.0 c.c. of toxin-producing staphylococcus culture in a total of eight ribs of six adult dogs. One wound opened and drained for two months. In one dog dying on the second day, an area of periosteum and pleura measuring 1 by 2 cm. was grossly necrotic, exposing bare bone, with the surrounding periosteum red and edematous. Microscopically (Figs. 4 and

5), the marrow proximal to the rib tip was acutely necrotic, with absorption of the cancellous bone and necrosis and early absorption of an area of cortex. The periosteum over this cortex also showed necrosis. More peripherally the periosteum was filled with polymorphonuclear leucocytes, separating periosteum and cortex. A similar process was seen in another rib after nine days, with the addition of beginning periosteal new bone formation in the less damaged periosteum. With longer periods of ten to forty-one days, increasing amounts of new bone were produced by the periosteum with resorption of some of the necrotic bone and sequestration of smaller portions (Figs. 6 B and 7). The amount of destruction in the ribs is variable. As seen by x-ray, some show extensive destruction of bone, extending from the tip almost to the vertebral end of the rib, with large amounts of involucrum; while others show only a tiny area of rarefaction near the cartilage junction and a minimum of new bone.

Nontoxin-producing staphylococci were similarly injected following a period of increased intramedullary pressure in five ribs of five adult dogs and examined after a period of thirty-four to fifty days. In three there was no demonstrable change and two showed slight thickening of the cortex with irregularity of the costochondral junction (Fig. 6 A).

Group V. The Effects of Increased Intramedullary Pressure and Intravenous Organisms.—A group of six experiments was done in which elevated intramedullary pressure, by the injection of saline solution into the rib, was maintained for sixteen to twenty hours at a pressure of 156 cm. and followed immediately by the intravenous injection of 0.25 to 1.5 c.c. of a broth culture of the toxin-producing staphylococcus. The wounds in these dogs healed without drainage; none of the dogs died as a result of the injection; and there were no other lesions noted at autopsy aside from the changes in the ribs. The dogs, one pup and five adults, were sacrificed after eleven to twenty-one days. One rib was only slightly altered in structure; the other five all showed enlargement of the tip of the rib and, on x-ray, a spotty destruction of the cortex and medullary portion of the distal few centimeters of the rib, with the formation of new bone about it (Fig. 6 C). The amount of bone destruction and new bone formation was as great as in those ribs in which the organisms were implanted directly, and much greater than in any of the ribs in which only increased intramedullary pressure was produced.

DISCUSSION

The difficulty in producing in experimental animals a process corresponding with acute hematogenous osteomyelitis of human beings is indicated by the numerous and varied methods which have been used in attempts to reproduce this disease. Rodet³ obtained abscesses in bone, without trauma, by the intravenous injection of staphylococci. Lexer,⁴ Robertson,⁵ and, more recently, Thompson and Dubos⁶ produced staphy-

lococcal infections in the metaphyses of long bones of young animals by the intravenous injection of organisms, without, however, reproducing the massive necrosis and sequestration seen in human osteomyelitis. Starr⁷ produced an experimental osteomyelitis by the injection into the nutrient artery of a mixed culture of organisms, but death of the animals occurred within forty-eight hours and only very early stages could be studied. Bancroft⁸ produced a chemical osteomyelitis by the introduction of croton oil into the medullary canal of long bones and Phemister⁹ similarly produced necrosis by radium. Haldeman¹⁰ produced osteomyelitis by introducing staphylococci through a drill hole in the cortex near the metaphysis. Baudet and Cahuzac¹¹ stated that they were unable to cause a true osteomyelitis by the intramedullary, subperiosteal or intravenous injection of staphylococci.

It has been amply demonstrated by the researches of Axhausen,¹² Brunschwig,¹³ Nussbaum,¹⁴ and Kistler¹⁵⁻¹⁷ that necrosis of bone does not lead to sequestration but to the production of new bone and gradual absorption of dead bone. When necrosis and infection are both present, not all the dead bone is sequestered, only that part most severely damaged.

By a combination of elevated intramedullary pressure and infection, massive necrosis and sequestration of diaphyseal bone, which very closely resemble that occurring in human osteomyelitis, have been produced by Larsen.¹ The experiments described in the present paper demonstrate that cortex and marrow may be killed and periosteum separated by increased intramedullary pressure. However, in the absence of infection, periosteum reattaches and new bone is laid down, substituting the necrotic bone without sequestration.

In our experiments the combination of necrosis of bone produced by elevated intramedullary pressure and the presence of virulent organisms, whether implanted directly or localized from the blood stream, does lead to sequestration. The sequestra, however, need not be extruded but are absorbed in situ. In Larsen's experiments primary stripping of periosteum was not a factor in the necrosis of bone, but in the presence of dead, infected bone periosteum separated and sequestration ensued. In the present experiments the stripping of rib periosteum by the saline solution is probably to be accounted for by the thin cortex, with large soft tissue and vascular spaces near the costochondral junction. Combined with the presence of large amounts of cancellous bone in the medulla, these factors direct the flow of saline solution through the cortex rather than down the medullary canal, as noted, with pressure concentrated in a small area of rib. By seepage of saline solution through the walls of the perforating periosteal vessels as they enter the cortex, saline solution may produce slight separation of the periosteum from the cortex. As this continues, these vessels are stretched and finally

torn across, so that saline solution may run freely from the cortex, beneath the periosteum, to strip it up.

The direct mechanical stripping of the periosteum by saline solution occurs at pressures which are probably much higher than any ever reached in the bone through infection. The separation of periosteum in the presence of infection, as seen in the microscopic sections, appears to be due to necrosis of the inner layer of periosteum, caused by a spread of bacterial toxin from the medulla through the cortex. As has been pointed out by Larsen, it is doubtful that the separation of the periosteum plays a great part in killing the underlying cortex by interfering with its blood supply.

The importance of the toxin elaborated by the staphylococcus in the production of necrosis of bone again is emphasized in these experiments, as has been pointed out by Stookey and co-workers¹⁸ and by Robertson.¹⁹ We have shown that nontoxin-producing organisms are well tolerated by ribs and cause no destruction of bone. The combination of increased intramedullary pressure and nontoxin-producing organisms results in hardly more alteration in the rib than the pressure alone. Toxin-producing staphylococci do cause necrosis of bone and marrow and, when combined with the necrosis succeeding upon elevated intramedullary pressure, cause extensive necrosis and sequestration, which greatly resemble human osteomyelitis. A remarkable fact is the rarity of a spontaneous draining sinus in these experiments and the readiness with which necrotic and even sequestered bone can be absorbed in the rib. Green and Shannon²⁰ comment on the fact that in infants acute osteomyelitis is less chronic and it is less usual for sequestration to occur, explaining these observations on the greater vascularity and spongy quality of infants' bones, factors which are also present in ribs.

SUMMARY

Increased intramedullary pressure, produced by the injection of salt solution into the ribs of dogs, leads to marrow and bone necrosis, with subsequent new bone formation, but without sequestration. Toxin-producing staphylococci cause necrosis of marrow and bone. Elevated intramedullary pressure caused by the injection of saline solution combined with toxin-producing staphylococci results in extensive bone necrosis and sequestration. In ribs sequestered bone may be absorbed without the formation of a sinus or the extrusion of the sequestrum.

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TUMORS OF THE SALIVARY GLANDS*

I. A REVIEW OF PROGNOSTIC DATA FROM THE LITERATURE

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FOR MANY years the difficult clinical and pathologic problems of tumors in the region of the salivary glands have attracted great interest. Investigations prior to the past decade have been largely directed toward a study of pathogenesis, but more recently follow-up studies with emphasis upon the clinical course have been reported.^{1, 2, 4, 6, 9, 10, 13, 14, 18, 19, 20, 22} Pathologists, surgeons, and radiologists have recorded divergent views in regard to treatment, and the results of treatment by any means have been sharply criticized.^{13, 14} It is therefore of interest to assemble and correlate the available clinicopathologic data as an aid in formulating a rational therapeutic plan.

The comprehensive monograph of Ahlbom, of Radiumhemmet, Stockholm, deserves especial consideration since it provides a vast sum of information derived from a complete review of previous publications along with a study of 254 salivary tumors. Since this work summarizes a wide experience with radiotherapy and is not generally available in this country, material has been freely drawn from it in the preparation of this paper.

An evaluation of the prognostic data in the literature is impeded by the lack of uniformity in pathologic nomenclature and classification, particularly with regard to malignancy. For this reason, along with the fact that pathology, treatment, and prognosis are interrelated in subject matter, a brief summary of pathology and treatment is presented.

PATHOLOGY

A variety of benign and malignant neoplasms occur in and about the salivary glands. Among the benign tumors are included angiomas, lipomas, and fibromas similar to those found elsewhere but of infrequent occurrence. Pure adenomas rarely have been described and their existence is doubted.^{1, 11} The adenolymphoma (onkcytoma), structurally a benign papillary cyst containing lymphoid tissue, is infrequently encountered.³

By far the greatest number of all salivary tumors are included in the so-called mixed tumor group. Varying greatly in structure and behavior, these bizarre, composite tumors may show either benign or malignant

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characteristics. Whatever its histogenesis, a mixed tumor apparently consists of both epithelial and connective tissue elements. Collections of epithelial cells with a variable cytology and arrangement are included in a mucinous, fibromyxomatous, or even myxocartilaginous stroma. The epithelial cells are for the most part glandular, but basal cell and squamous cell types, even epithelial pearls, may be included.

Most salivary tumors of clear-cut malignancy are considered to be adenocarcinomas, although the distinction between adenocarcinomas and malignant mixed tumors is not always well defined. Cuboidal cell cancer, said to arise from the small ducts, and a rare type of cancer composed of small spindle and round cells (small cell carcinoma of Chevassu) are recognized, and a basal cell type of carcinoma which must be distinguished from the typical mixed tumor has been discussed.^{1, 22} Squamous cell carcinoma may be found in a typical mixed tumor, but squamous cell carcinoma growing in the salivary glands may represent metastasis to lymph nodes from the nasopharynx or branchiogenic carcinoma with secondary invasion of the gland.

Sarcoma is unusual in the salivary glands since the glands are primarily composed of epithelium. Malignant melanoma, lymphosarcoma, and other varieties of sarcoma probably arise from the lymph nodes and fibrous tissues in and around the glands and should not be considered true salivary tumors.¹

HISTOGENESIS

Numerous theories of derivation have been advanced, attempting to explain the varying types of epithelium and stroma of mixed tumors. The earlier theories of endothelial and connective tissue origin have been generally abandoned. The prevailing theories may be summarized:

1. Single tissue origin:
 - a. From the epithelium of the salivary or mucous glands.
 - b. From detached salivary gland anlage formed during the invagination of the buccal epithelium.
2. Dual tissue origin:
 - a. From branchial cleft inclusions (three germ layers).
 - b. From embryonal nonbranchial anlage (ectoderm and mesenchyme).

The theories of dual tissue origin most easily explain the fibro-epithelial components as well as the not uncommon finding of composite tumors at the sites of union of branchial clefts and embryonal facial fissures. Recently, a relationship of anatomic distribution between basal-cell carcinomas and mixed tumors of the face with respect to embryonal facial fissures has been presented,¹⁶ adding support to the view of embryonal origin.

On the other hand, proponents of the epithelial, single tissue origin explain the myxomatous and cartilaginous stroma as due to the mucous secretion of the epithelial glandular cells with "immersion" of the

intracellular fibrous stroma and subsequent hyalinization. This view presupposes that composite tumors of the oropharynx, face, lachrymal glands, and other regions arise from the small mucous, salivary, and lachrymal gland epithelia or their anlage.

The possibility that tumors generally included in the mixed tumor group may arise from several sources has been suggested.^{6, 8} Several recent studies have indicated that the intraoral tumors are less complex than those occurring about the face, neck, and scalp.^{1, 8, 15} The extraoral tumors are said to be derived from ectodermal inclusions formed in fusion of the branchial clefts and fissures, and the intraoral tumors formed during the invagination of the oral ectoderm in the development of the normal salivary and mucous glands.⁸

CLASSIFICATION

With most of the pathologic and clinical problems centering upon the so-called mixed tumor group, the lack of a standard nomenclature and classification retards an accurate therapeutics and prognosis. Descriptive terms have been applied to individual mixed tumors in the past. At present, the general tendency is to group them on a histogenetic basis, with a simplified nomenclature. The term mixed tumor is applied to composite tumors if a dual tissue origin is accepted, and mucous and salivary gland tumors if a single tissue, epithelial origin is preferred. Confusion still exists, however, since:

1. Theories of histogenesis have been inconclusive.
2. The histologic structure varies widely and the personal equation enters into any histologic grouping (Table I).
3. Microscopic differentiation of the benign from the malignant is frequently impossible.¹²
4. The clinical behavior of individual tumors is quite variable, and often does not conform to the microscopic picture.¹²⁻¹⁴

TABLE I
COMPARISON OF PATHOLOGIC GROUPINGS

	TOTAL CASES	MIXED TUMORS			CAR- CINOMAS	SAR- COMAS
		BENIGN	SEMI- MALIGNANT	MALIGNANT		
Martin and Elkin ⁹	24	11		10	3	
Schreiner and Mat- tick ²⁰	48	37			11	1
Wakeley ²⁴	52	40			12	
Benedict and Meigs ²	78	39			30	9
Stewart ²³	28	12		8	8	
Patey ¹⁸	52	29	15	8		
Stein and Geschick- ter ²²	241	199			42	
Ahlbom ¹	214	80	37	30	61	6
Houck [*]	48	25		12	9	

*See Part II, SURGERY 6: 565, 1939.

Efforts to obtain a pathologic classification of salivary tumors which will indicate the clinical course and prognosis in individual cases have

been made with poor success. After reviewing the efforts of previous investigators in attempting to determine the malignancy of the so-called mixed tumors, MacFarland^{13, 14} concluded that "the microscope, beyond showing that the lesion is a mixed tumor, is misleading rather than enlightening." He decided that "structure and duration have to be considered together, both in making the diagnosis and in deducing a prognosis." He classified salivary tumors simply as mixed tumors and carcinomas. All mixed tumors were considered "potentially malignant."

Stein and Geschickter²² singled out the character of the stroma as the most reliable microscopic index of a benign tumor: "The slower the rate of growth, the larger the amount of stroma and the more often is cartilage found." A basal cell type was distinguished from the typical mixed tumor. Three types of carcinoma were noted.

Martin and Elkin⁹ recognized two groups of salivary tumors. The first is characterized by long duration, mobility, and a sharp outline with a well-formed capsule. The stroma is thick and hyalinized, and cartilaginous tissue is frequent. Epithelial cells are dark and polyhedral, in cords. In the second group, encapsulation is usually present, but the tumor is fixed. The tissue is soft and the cells are hyperchromatic and more uniform, with attempts at gland formation and scanty stroma. The latter group was judged to be of more active growth.

Patey¹⁸ studied fifty-five cases of tumors of the salivary glands, including similar tumors found about the face and oropharynx, and classified them in four groups on the basis of cellularity. The clinical results were compared with the histologic grading and malignancy apparently varied directly with the degree of cellularity and dedifferentiation of cells.

Ahlbom¹ prefers the term mucous and salivary gland tumors, to include all tumors of the large salivary glands as well as similar tumors occurring elsewhere about the head and neck. In his classification, the use of descriptive terms demonstrates the relation of structural components to malignancy. The terms basalioma, cylindroma, and adenocystic basal-cell epithelioma are more or less synonymous, but Ahlbom has restricted the term basalioma to benign or malignant tumors resembling basal-cell cancer. This classification, which was developed by Reuterwald, of Radiumhemmet, appears on page 554.

The basis of classification of Ahlbom's three subgroups appears on page 554.

Polymorphous and atypical cells are concepts which in the above scheme mean that the cells show a marked irregularity in comparison with the cells in benign mixed tumors. The benign tumor contains cells which are atypical and polymorphous but to a lesser degree and arranged in characteristic architecture. A relative degree of variation in the cells must be determined. In semimalignant tumors, features resembling infiltrative growth may be found. Tumor cells may lie

adjacent to nerves, blood vessels, and muscle, but an impression of a tendency toward encapsulation is obtained. Stricter rules in regard to infiltrative growth must be used in mixed salivary tumors in comparison to tumors in general, since the benign salivary tumors will invade the capsule to some extent.

CLASSIFICATION OF AHLBOM

		NO. OF CASES
A. Benign tumors		
1. So-called mixed tumors		76
Fibromyxoeipithelial	33	
Fibroepithelial	1	
Fibromyxochondroepithelial	42	
2. Adenoma		2
3. Papillary cystic adenoma		1
4. Basalioma (with cylindromatous features)		1
	Total	80
B. Semimalignant		
1. So-called mixed tumors		25
Fibroepithelial	4	
Fibromyxoeipithelial	17	
Fibromyxochondroepithelial	3	
Fibromyxoma (without definite epithelium)	1	
2. Papillary cystic adenoma		7
3. Basalioma		5
With cylindromatous features	3	
Solid	2	
	Total	37
C. Malignant		
1. So-called mixed tumors		34
Fibroepithelioma	14	
Fibromyxoeipithelioma	11	
Fibromyxochondroepithelioma	5	
Fibromyxosarcomatous (without epithelium)	4	
2. Predominantly adenocarcinomatous type		7
3. Predominantly papillary cystic		10
4. Predominantly basal-cell type (cancer)		20
With cylindromatous features	23	
Solid	6	
5. Of predominantly squamous-cell cancer type		4
6. Slightly differentiated or undifferentiated epithelial		11
7. Slightly differentiated or undifferentiated without epithelial structures		2
	Total	97

BASIS OF CLASSIFICATION OF AHLBOM'S SUBGROUPS

- A. Malignant tumors
 1. The presence of metastases
 2. Infiltrative and destructive growth, with no tendency toward encapsulation
- B. Semimalignant tumors
 1. A complete capsule in which there may be tumor nodules if the tumors are:
 - a. Cellular and little differentiated with sparse intercellular substance
 - b. Distinguished by cells which are atypical and polymorphous, with hyperchromatic or polymorphous nuclei, perhaps with a noticeable number of mitoses
 - c. Basaliomas (with or without cylindromatous features) which have a structure suspicious of malignancy
(Some of these features may be found together in the same tumor)
 2. Tumors which present nodules outside the capsule or which have broken through the capsule, but still show a tendency toward encapsulation
- C. Benign tumors

Encapsulated tumors which exhibit none of the above features

Nodules in the capsule with a benign structure or similar nodules outside the capsule, if provided with their own well-formed capsule, do not prevent tumors from being placed in this subgroup

HISTOLOGIC CRITERIA OF MALIGNANCY

In reviewing the assembled schemes of classification, it appears that clear-cut benign and malignant groupings are frequently unsatisfactory. A borderline group (or groups) of relatively low-grade malignancy is usually recognized. Accordingly, microscopic criteria of malignancy are only of relative value and each suggested criterion must be considered in the composite microscopic picture. No single criterion is strictly reliable except the typical histologic picture of undifferentiated pure carcinoma and the finding of metastases. The concept of relative malignancy must be kept constantly in mind. Microscopic features which have been used in determining the malignancy of salivary tumors in the quoted literature are summarized as follows:

1. Scanty stroma; lack of complex structure
2. Absence of cartilage-like tissue
3. Cellularity
4. Nuclear changes; polymorphism
5. Dedifferentiation of epithelial cells
6. Basal cell characteristics, usually adenoecystic (Stein and Geschickter)
7. Papillary cystic structures (Ahlbom's tables)
8. Invasion of adjacent normal tissues
9. The typical picture of carcinoma
10. Metastases

AGE INCIDENCE

Salivary tumors may appear at any age. In Ahlbom's series, benign and semimalignant tumors first were noticed at an average age of 37 years, with the youngest at the age of 2 and the oldest at the age of 84 years. The average duration before coming to treatment was 7.1 years for the benign and 4.9 years for the semimalignant tumors of the salivary glands. The definitely malignant growths first were noticed at an average age of 46.5 years, with the average duration before treatment of 7.2 years. These figures, quoted from Ahlbom,¹ are in close accord with those of other observers.

CLINICAL COURSE

The typical mixed tumor of the parotid region is the prototype for salivary tumors, both in histologic structure and clinical course. The more benign tumor appears as a small pea-shaped nodule in the region of the gland, which usually progresses slowly to an irregular, rounded, nodular mass of firm consistency, attached to or embedded in the parotid gland. As a rule, the tumor is well circumscribed and movable, with no fixation to the skin or deeper soft tissues, and well encapsulated by a thick, fibrous capsule. Untreated, the more benign tumors may grow slowly for many years, reaching the size of a grapefruit or larger. Subjective symptoms are insignificant, although deeply situated growths

may produce pressure symptoms. The clinical course of Ahlbom's semi-malignant group resembles that of the benign tumors. However, the rate of growth is somewhat more rapid, and partial or complete fixation to the deeper soft tissues is more common.

Malignant tumors are also irregular and rounded, but the consistency is more apt to be hard. In individual instances the consistency may be elastic or soft. Fixation to the skin and deeper structures is characteristic. Enlargement of the adjacent lymph nodes occurs, not always indicating metastatic involvement. In general, malignant tumors grow more rapidly, but salivary carcinomas grow more slowly than most carcinomas occurring elsewhere. The surrounding soft tissues and bony structures are invaded by direct extension. Subjective symptoms are more common than in benign tumors, due to invasion of the surrounding parts. Spontaneous facial paralysis is frequent. With invasion of the base of the skull, mandible, and oropharynx, extremely severe pain may develop, ranking with the most severe pain produced by any malignant tumor. Metastases occur late, indicating a relatively lower grade of malignancy than carcinomas in general. Death follows wide invasion of the neck and the base of the skull.

CLINICAL CRITERIA OF MALIGNANCY

1. *Age of the Patient.*—Malignant tumors occur at a somewhat later average age, but there is no sharp diagnostic distinction.

2. *Duration of the tumor* is not significant. The average duration is about the same for the benign and the definitely malignant growths.

3. *Rate of growth* is generally more rapid in definitely malignant tumors.¹ A tumor which reaches a size sufficient to bring the patient to operation within one year and which presents the microscopic picture of carcinoma offers a poor prognosis.¹³

4. *Acceleration of growth* has been mentioned¹³ as possible evidence of activation of latent malignant tendencies.

5. *Subjective symptoms* are much more common in definitely malignant tumors.

6. *Spontaneous facial paralysis* is frequent in the malignant and rare in the benign neoplasms.¹

7. *Location.*—Tumors of the oropharynx are less complex and more frequently malignant than those of the large salivary glands¹⁷ and should always be considered carcinomatous.¹⁷

8. *Consistency.*—The more malignant tumors are more often of a hard consistency, but this is not a reliable diagnostic distinction.¹

9. *Mobility.*—The most obvious clinical difference between malignant and benign tumors is that most malignant tumors are fixed to the skin or deeper tissues and are seldom movable, while most benign tumors are freely movable.¹

10. *Metastasis*.—About 20 per cent of malignant tumors of the large salivary glands present lymph node metastasis in the neck. Distant metastases are almost never demonstrable at the stage in which a patient comes to treatment.¹

TREATMENT

The treatment of salivary tumors is particularly impeded by several factors:

1. A wide surgical excision of tumors of the neck may involve the sacrifice of nerves and blood vessels with resultant cosmetic disfiguration and functional disability.

2. Recurrence is frequent after surgical removal.

3. Salivary tumors are less radiosensitive than tumors in general.

4. The clinical and microscopic differentiation of benign from malignant tumors is not easy and at times impossible.

5. A satisfactory pathologic and clinical classification is lacking.

The traditional treatment has been surgical removal. Incomplete excision from fear of damage to the facial nerve or due to adherence of the tumor to the deep structures has made surgery too frequently ineffective. Radical operation produces facial nerve paralysis, while incomplete excision fails to cure the disease. The operation is usually more radical when a definite malignancy is suspected.

Since the microscopic diagnosis of malignancy is frequently inconclusive, preliminary biopsy is seldom justified. Violation of the protective capsule and operative trauma may increase the rate of growth and tendency toward invasion.¹⁵ In view of the complex, variable tissue structure, a complete excision offers a better pathologic examination.¹⁴ Benedict and Meigs² advocate immediate frozen section at the time of operation to determine the extent of the procedure; excision of the parotid gland, sacrifice of the facial nerve, and a complete neck dissection are done if the microscopic diagnosis is carcinoma.

Excision by sharp dissection is considered the best method of surgical eradication. Extracapsular enucleation by blunt dissection is widely practiced to avoid facial nerve injury, but recurrences are said to be more common than with excision; intracapsular curettage without removal of the capsule is not effective, since tumor cells are present in the capsule.²²

The operative technique used by Hybbinette, of Stockholm, Sweden,¹ deserves special consideration. Small, well-encapsulated, freely movable tumors are excised or enucleated. In other cases, which generally might be considered inoperable, the capsule is incised and the tumor tissue removed from within the capsule with a spoon, with the wound protected from implantation of tumor particles. Afterwards, the capsule is dissected out by blunt instruments with one finger within the capsule, which is removed intact. The capsule, which usually contains tumor

may produce pressure symptoms. The clinical course of Ahlbom's semi-malignant group resembles that of the benign tumors. However, the rate of growth is somewhat more rapid, and partial or complete fixation to the deeper soft tissues is more common.

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5. *Subjective symptoms* are much more common in definitely malignant tumors.

6. *Spontaneous facial paralysis* is frequent in the malignant and rare in the benign neoplasms.¹

7. *Location*.—Tumors of the oropharynx are less complex and more frequently malignant than those of the large salivary glands^{14, 17} and should always be considered carcinomatous.¹⁷

8. *Consistency*.—The more malignant tumors are more often of a hard consistency, but this is not a reliable diagnostic distinction.¹

9. *Mobility*.—The most obvious clinical difference between malignant and benign tumors is that most malignant tumors are fixed to the skin or deeper tissues and are seldom movable, while most benign tumors are freely movable.¹

4. Tumors which prove themselves to be radioresistant (the majority) are radiated with moderate doses and then operated on if they are, or become, operable.

5. Operable and inoperable tumors which show themselves to be radio-sensitive at the primary radiation, and where there is a prospect of cure without operation (as a rule, malignant tumors), should receive a large dose of external radiation or a smaller dose which is afterwards supplemented by intratumoral radium. It is wiser, however, to use irradiation combined with surgery for the most part in tumors of this type.

6. Other tumors (little radiosensitive or radioresistant, inoperable) are radiated for palliative purposes.

7. After operation on the benign and semimalignant tumors, radium should be placed in the wound cavity. Such treatment also can be used for malignant tumors, but there it is more important to give post-operative external radiation over the scar and its surroundings. In spite of the relatively rare occurrence of lymph node metastases, it must be considered safest to include the regional lymph nodes in the latter form of treatment.

8. In operations on tumors, especially malignant ones, in the oral cavity, upper respiratory passages, and middle ear, electroendothermy should be used if possible.

9. Lymph node dissection should not be done unless suspicious lymph nodes can be palpated and do not disappear after radiation.

10. Even if these principles are followed in the main, the treatment must always be individualized to a certain extent. In the individual case attention must be paid to the age and general condition of the patient, to his social conditions, to the situation, size, and extent of the tumor, to the presence of metastases, etc.

In Ahlbom's work the technique and dosage of x-ray and radium are described in detail. The principle of a preliminary therapeutic trial with irradiation is apparently of value.

PROGNOSIS

The following outline represents a digest of the reported experiences of various authors in regard to the apparent effect of different forms of treatment on the prognosis:

A. *Benign, Mixed Tumors*

1. *Untreated* (conservative treatment recommended by McFarland^{13, 14}).

a. *Life Expectancy*.—Most benign, mixed tumors grow slowly over a long period of years without endangering life, although many tumors which are microscopically benign exhibit rapid growth.^{13, 14}

b. *Symptoms and Disfigurement*.—Slowly growing tumors give almost no symptoms until a large size is reached, when pressure

cells, is said to be more completely removed by this method. Radiumhemmet cases operated on by this technique showed an insignificant frequency of recurrence (one in twenty-five) and no injuries to the facial nerve occurred. The use of preoperative x-ray therapy is said to facilitate removal of the tumor by surgery, due to edema of the fascial and fibrous tissues about the capsule which provide a good plane of cleavage. Operation does not carry increased danger of infection or delayed healing when it has been postponed until the radiation reaction is practically past, usually three to six weeks after conclusion of the preoperative radiation. This method is used for large or fixed tumors.

All types of external and interstitial irradiation have been employed in treating salivary tumors. Methods and dosage have not been standardized and have rapidly changed with the evolution of a more efficient radiologic technique. Although the results are frequently disappointing and the tumors relatively ray resistant,^{1, 16, 20} good results are obtained in individual instances. Current opinion favors surgery as the chief reliance, to be supplemented by high voltage x-ray therapy or radium element packed in the surgical wound, with deep x-ray therapy used alone for large inoperable neoplasms. Interstitial implants of emanation or radium element have been largely abandoned^{1, 11, 16} except in the treatment of an occasional small recurrence.

At the Radiumhemmet, Stockholm, Sweden, radiotherapy has been used for many years in the treatment of salivary tumors. Ahlbom¹ recently has reported the results of 254 cases treated at that clinic, with especial attention to the methods of radiotherapy. Intensive irradiation is said to bring about a decrease of size in these tumors, presumably acting upon the tumor epithelium for the most part. The response of the tumors to irradiation is quite variable, being greatest in the group of malignant tumors and in general being less in the semimalignant and least in the benign groups. About one-half of the most malignant tumors show no response. Individual tumors show a rapid response to radiation therapy. Ahlbom believes that the radiosensitivity of malignant salivary tumors is comparable to carcinomas of the breast and squamous cell cancers of the mouth, which are among the more radioresistant squamous cell cancers. Ahlbom has formulated the following plan of treatment:

1. Practically all cases should be treated. The only exceptions are patients with general debility or with visceral metastases, and very old patients with completely benign, very slowly growing tumors.

2. Treatment should be given at as early a stage as possible.

3. The treatment should be initiated with fractional external radiation. One may forego this radiation, however, in the case of clearly benign, slowly growing, superficially situated, and very easily enucleated tumors. When radiating the malignant tumors, the regional lymph node area should be included.

McFarland's tabulation represents the only attempt at clinical classification of operability in the literature. The table does not take into account the mobility or fixation of the neoplasm and gives no figures as to facial nerve damage with respect to size of the tumor. The findings are at variance with the surgical principle of removing a tumor at the earliest moment.

- c. *Influence of Trauma on Rate of Growth.*—Incomplete excision may accelerate the rate of growth by removing or damaging the protective capsule.^{9, 14, 22} It is doubtful that a tumor may become more malignant with each recurrence. The histologic structure of a recurrence is nearly always that of the original growth.^{1, 2, 22}
- d. *Postoperative Complications.*—Facial nerve paralysis is a frequent injury, but it is more common after removal of the malignant tumors, when the nerve is deliberately sacrificed. Other postoperative complications, such as salivary fistula and ankylosis of the jaw, are unusual.

TABLE IV
DAMAGE TO FACIAL NERVE BY SURGERY
(PARTIAL AND COMPLETE)

	TOTAL	BENIGN	MALIGNANT
Benedict and Meigs ²	13.7%	7.5%	20.0%
Stein and Geschickter ²²		10.0%	
McFarland ¹³	4.4%		
Ahlbom ¹	16.9%	11.0%	36.6%

3. *Treated by Irradiation Only.*—Benign mixed tumors are essentially ray resistant. Irradiation may shrink the mass to a smaller size, but a lump usually remains. Many respond only slightly, if at all. The size may be controlled and even an apparent cure obtained in individual cases (Quick and Johnson, quoted by Ahlbom). A single case was successfully treated by Ahlbom.¹
4. *Treated by Surgery Combined With Irradiation.*—Ahlbom strongly advocates preoperative x-ray therapy and the postoperative application of radium element in the wound. His statistics indicate a much lower rate of recurrence than by surgery alone for benign neoplasms, with no deaths from the tumor.

TABLE V (FROM AHLBOM¹)
BENIGN TUMORS—TREATED BY COMBINED SURGERY AND IRRADIATION

FOLLOW-UP PERIOD	NO. OF CASES	RECURRENCE	
		NO.	%
2 yr.	88	2	2%
3 yr.	71	2	3%
5 yr.	40	1	2½%
8 yr.	24	2	8%
11 yr.	15	1	7%

on adjacent structures may cause discomfort. From fifteen to thirty years may be required for the growth to produce marked cosmetic disfigurement.

- c. *Development of Malignancy*.—A small percentage of tumors which are at first apparently benign and slow growing later exhibit acceleration of growth and become invasive. Several explanations have been offered:

- (1) A benign tumor undergoes malignant "degeneration."^{13, 23}
- (2) Such tumors are malignant or potentially malignant from the start.^{1, 14, 17}

2. *Treated by Surgery* (generally considered the chief reliance).

- a. *Life Expectancy*.—Usually a normal life span if the growth is properly excised. Repeated recurrences may end in destruction of life by invasion of the neck and head in instances in which the neoplasm was considered microscopically benign.¹⁴
- b. *Recurrence of the tumor* can take place up to forty-seven years after removal and it thus is impossible to prove that any case is completely cured.¹⁴

TABLE II
BENIGN MIXED TUMORS—TREATED BY SURGERY ONLY

	FREQUENCY OF RECURRENCE
McFarland ¹⁴	25%
Benedict and Meigs ²	42.5%
Wood ²⁵	45%
Stein and Geschickter ²²	20%

Ahlbom¹ has estimated that from 20 to 25 per cent of benign tumors, treated by surgery only, recur within three years. The recurrence rate is lowest after excision, greater following enucleation, and greatest with intracapsular curettage without removing the capsule.²³ Hybbinette¹ has noted only 4.7 per cent recurrence after intracapsular curettage combined with immediate complete removal of the capsule (see previous description of technique).

McFarland^{13, 14} has stressed the importance of waiting to remove a salivary tumor until it has reached the size of a lemon or greater (become "ripe"). In his series recurrence was more frequent when the tumor was removed while small.

TABLE III (AFTER MCFARLAND)
RECURRENCE OF SALIVARY TUMORS WITH RESPECT TO SIZE

SIZE	TOTAL NUMBER	RECURRENCE
Smaller than a walnut	28	32.1%
Walnut to lemon (inclusive)	109	17.4%
Larger than a lemon	19	10.0%

2. The malignancy is of variable degree and is often of low grade, a "relative" malignancy.
3. Evaluation of published prognostic data is impeded by lack of uniformity in pathologic nomenclature and classification, particularly in regard to malignancy.
4. The microscopic determination of malignancy is difficult and frequently inconclusive. The criteria of individual pathologists differ.
5. Preliminary biopsy is condemned and a clinical preoperative diagnosis is preferable, particularly since pathologic classifications have proved unsatisfactory as a guide for treatment.
6. Fixation of the tumor to the skin or deeper structures, with lack of mobility, stands out as the most reliable clinical sign of malignancy.
7. A therapeutic trial with irradiation appears to be a valuable guide in diagnosis and treatment.
8. Current opinion favors surgery combined with radiotherapy in most cases, although treatment must be individualized.
9. Treatment of the more benign tumors by surgery has given fairly good results, although recurrences and facial nerve injury are quite frequent. Better results have been obtained at the Radiumhemmet by combined surgery and irradiation.
10. Treatment of malignant tumors by surgery alone is unsatisfactory. Most patients have died within two years after operation, contrasting with the average preoperative duration of seven years. Radiation alone or radiation combined with surgery prolongs life and occasionally gives a brilliant result.
11. McFarland's suggestion that many patients are better left untreated should serve as a check on useless or harmful surgery.
12. There is need for a satisfactory classification based on clinical findings and follow-up results as an index of operability.

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B. *Semimalignant Tumors* (Semimalignant group has been used only by Ahlbom, and the data below are taken from his monograph).

1. *Untreated*.—Ahlbom believes that more active malignancy may develop, the semimalignant tumors becoming more definitely malignant. Recurrences were histologically clearly malignant.
2. *Treated by Surgery Only*.—None.
3. *Treated by Radiotherapy Only*.—Five cases were so treated because of radiosensitivity and disappeared after irradiation. A single case recurred, after fourteen years, and the recurrence was eradicated by further irradiation.
4. *Treated by Surgery Combined With Radiotherapy*.—The recurrence rate was double that of the benign group and three patients died from the tumor. Three recurrences were histologically more malignant than the original semimalignant neoplasm.

C. *Malignant Tumors*

1. *Untreated tumors* exhibit a relatively low grade of clinical malignancy compared with other carcinomas and sarcomas. Grow rather slowly, with the rate of growth accelerated in the terminal stage. Inevitably fatal, death resulting from invasion of the neck and head after a horrible, extremely painful terminal course. Metastases occur late.
2. *Treated by Surgery*.
 - a. *Life Expectancy*.—Average less than 2 years after operation.^{1, 2, 13} Operative trauma appears to accelerate growth.¹³ Recurrence and death from the tumor are almost certain. Facial nerve paralysis usually follows operation and there is a definite operative mortality.
3. *Treated by Radiotherapy Only*.—Radiation therapy has been considered by many to be of little benefit.^{2, 14, 21} Ahlbom¹ reports 32 per cent of 62 cases free from symptoms and signs after 2 years, and 23 per cent of 39 cases free from symptoms and signs after 5 years, along with 2 cases well after 11 years.
4. *Treated by Surgery Combined With Radiotherapy*.—Benedict and Meigs² found that irradiation after operation prolonged life for several years but did not cure the disease. In the Radiumhemmet series,¹ of 62 cases, 58 per cent were free from signs and symptoms after 2 years; and 40 per cent of 35 cases after 5 years; 6 survived for 8 years, and 2 for 11 years, free from symptoms.

SUMMARY

From the assembled literature, a number of pertinent facts are outstanding:

1. Although many salivary neoplasms pursue a benign course, all such tumors must be considered potentially malignant.

TUMORS OF THE SALIVARY GLANDS*

II. A STUDY OF 48 CASES, WITH THE PRESENTATION OF A NEW CLINICAL CLASSIFICATION

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THE PRESENT study presents a series of cases of tumors of the salivary glands for correlation with data from the literature. A simple practical classification based entirely on clinical findings is offered as a basis for treatment and prognosis.

Forty-eight tumors of the parotid, submaxillary, and sublingual glands from the files of the University of Virginia Hospital have been reviewed and studied. The microscopic structure of four cases was that of epidermoid carcinoma; of one, pigmented melanoma; and of another, chronic inflammation of the submaxillary gland. These cases were included since they had been diagnosed and treated as tumors of the salivary glands. The records have been analyzed and the patients brought back for examination when possible. Follow-up data were obtained by letter or from the hospital records in many instances. Complete information as to the postoperative course and survival was obtained in forty cases. An attempt to trace six other patients, who failed to answer final inquiries, was made by investigation at the Bureau of Vital Statistics of the State of Virginia, and no death certificate was recorded in any such instance. Since these six individuals lived in this state, it may be assumed that in all probability they are still living. All attempts to trace two patients failed.

Microscopic slides were reviewed by serial number and a "revised pathological diagnosis" was reached without reference to the clinical course. The type of epithelium and other microscopic points of interest were tabulated in an attempt to evaluate the various microscopic criteria of malignancy which have been suggested in the literature. Pathologic and clinical data are assembled in Table I.

PATHOLOGY

From the histologic structure alone the tumors were listed according to the revised pathological diagnosis (Table II).

The simplest possible system of pathologic classification was selected. The placement of individual cases in this classification was based on pathologic criteria roughly similar to those of Ahlbom.¹ However, if the

*An abridged transcription of a thesis presented for the Master of Science degree, University of Virginia, 1938.

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HOUCK: TUMORS OF SALIVARY GLANDS—II

	82433	17	0	I	?	S	40 yr.	Well 6 yr. to date	2	Glandular, cylindroma	1	0	0	0	Mixed tumor	Benign mixed tumor (cylin- droma)
50234	19	0	III	3	S	6 yr.	Well 11 yr. to date	0	4	None present, pure myxofibroma	0	0	0	0	Fibroma	Fibroma (sublingual gland)
59789	11	0	I	2 inv.	S	8 yr.	Well 10 yr. to date	3	2	Glandular, adenocystic	2	0	3	0	Mixed tumor	Benign mixed tumor
58944	38	0	III	?	S	5 yr.	Well 10 yr. to date	1	4	Glandular, adenocystic	1	0	4	0	Mixed tumor	Benign mixed tumor
64375	19	0	I	?	S	10 mo.	Well 9 yr. to date	2	3	Glandular, solid, and adenocystic	2	0	4	0	Mixed tumor	Benign mixed tumor
94391	59	6 mo.	III	3 inv.	S	1 yr.	Well 4 yr.; died pneumonia	2	3	Glandular, adenoid	1	0	2	0	Mixed tumor	Benign mixed tumor
121803	9	0	I	1 inv.	S	40 yr.	Well 7 mo to date	3	1	Glandular, mostly solid, scanty ade-noid	2	1	0	0	Mixed tumor	Benign mixed tumor
80856	24	0	I	2	S	3 yr.	?	1	4	Glandular, slight adenoid	1-2	0	0	0	Mixed tumor	Benign mixed tumor
1115870	31	0	II	4 inv.	S	5 yr.	Well 16 mo. to date	3	2	Glandular, solid masses	2-3	0	2	0	Mixed tumor	Benign mixed tumor

TABLE I
BENIGN MIXED TUMORS

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOEKER)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA								ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS		
68515	33	1 yr.	II	3 inv.	S	15 yr.	Well 8 yr. to date	2	3	Glandular, adenocystic areas	1-2	0	4	0	0	Mixed tumor	Benign mixed tumor
55028	23	6 mo.	I	4	S	15 yr.	Unknown	3	2	Glandular, adenocystic, cylindroma- tous	1-2	0	4	0	0	Mixed tumor	Benign mixed tumor
117614	37	0	I	4	S	3 yr.	Well 1 yr. to date	3	1	Glandular, slight adenoid tendency	3	0	0	0	0	Mixed tumor	Benign mixed tumor
117331	27	1 yr.	I	2	S	3 yr.	Well 1 yr. to date	1	4	Glandular	2	0	0	0	0	Mixed tumor	Benign mixed tumor
87536	33	1 yr.	I	3	S	30 yr.	Well 2 yr. to date	2	3	Glandular, slight adenoid tendency	2	0	6	0	0	Mixed tumor	Benign mixed tumor

*See latter part of paper.
†S = Simplex

*See latter part of paper.

†Encapsulation graded 1, 2, 3, and 4 to indicate thickness and completeness of encapsulation. Inv. indicates invasion of the capsule by tumor growth.

‡S. Surgiced; R. radiotherapy; S & R, surgery combined with radiotherapy.

§Anaplasia or dedifferentiation graded 1, 2, 3, and 4 after the method of Broders. Numbers 1, 2, 3, and 4 are used in the other columns to indicate quantity or degree.

HOUCK: TUMORS OF SALIVARY GLANDS—II

84263	41	0	I	?	8	3 yr.	Well 4 yr. to date	3	2	Glandular, mostly solid masses	2-3	0	0	0	0	Myxocar- cinoma	Benign mixed tumor
107450	48	3 yr.	IV		S	12 yr.	Well 2 yr. to date									Mixed tumor	Benign mixed tumor
26797	22	2 mo.	I	3	S	4 yr.	Well 17 yr. to date			No slide—Clinical diagnosis							Benign mixed tumor
86363	51	0	III	?	None	15 yr.	Good health 3 yr. after diagnosis			No slide—Clinical diagnosis							Benign mixed tumor
48543	14	0	III		S	4 wk.	Well 17 yr. to date			Not a tumor							Benign mixed tumor (clinical)
MALIGNANT MIXED TUMORS																	
96322	55	0	I	3 inv.	S & R	1 yr.	Died 4 yr. postopera- tively of "heart trouble"	2	3	Glandular solid masses	3	0	0	0	0	Adeno- carci- noma, parotid	Semima- lignant mixed tumor
94685	61	0	I	3 inv.	S	9 mo.	Well 4 yr. to date	4	1	Glandular solid masses	3	1	0	0	0	Adeno- carci- noma	Semima- lignant mixed tumor
58313	44	0	I	3	S	6 yr.	Died 4 yr., psychosis	2	3	Basal and squamous type of epidermoid epithelial pearls	2	0	0	0	0	Myxoed- ematous noma	Semima- lignant mixed tumor

TABLE I--CONT'D
BENIGN MIXED TUMORS

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOCK) *	ENCAPSULATION†	TREATMENT†	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA								ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS	
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA‡	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS			
51301	31	0	III	?	S	6 yr.	Well 11 yr. to date	2	3	Glandular cell masses	3	0	0	0	0	0	Myxo- enoma	Benign mixed tumor
32130	13	0	I	?	S	1 yr.	No death certificate 15 yr.	2	3	Glandular cell masses	2-3	0	?	0	0	0	Mixed tumor	Benign mixed tumor
30129	35	2 wk.	II	3 inv.	S & R	10 yr.	Well 10 yr. to date	3	2	Glandular, adenocystic, basal cell character	1-2	0	0	0	0	0	Basal cell car- cinoma	Benign mixed tumor (basal cell type)
37503	25	0	I	?	S	10 yr.	Well 14 yr. to date	2	3	Glandular	3	0	0	0	0	0	Mixed tumor	Benign mixed tumor
105932	29	0	II	4 inv.	S	30 yr.	Died 2 yr., pneu- monia	2	3	Glandular masses, slight adenoid tendency	1-2	0	2	0	0	0	Mixed tumor	Benign mixed tumor
91851	20	0	II	2	S & R	3 yr.	No death certifi- cate, 4 yr.	2	2	Glandular, adenocystic, and masses, pearls	1-2	0	2	0	0	0	Mixed tumor	Benign mixed tumor

	99773	15	0	III	2	S & R	2 yr.	Well 4 yr. to date; recurred 1 yr.	4	2	Glandular adenoid cystic	2	0	0	0	0	Adeno- carcinoma, parotid	Malignant mixed tumor
	42848	37	0	III	0	S & R	6 yr.	Died from tumor 14 mo. post-operatively	3	2	Glandular solid masses	3	1	0	0	0	Mixed tumor, malignant	Malignant mixed tumor
	41905	24	2 mo.	IV	3	S & R	20 yr.	Well 12 yr. to date	4	1	Glandular type almost absent	4	3	0	0	0	Mixed tumor, malignant	Mixed tumor semi-malignant
	11582	34	6 yr.	IV	?	S	28 yr.	Died 4 mo. from tumor			Clinical diagnosis					0	Mixed tumor or sarcoma (clinical)	Mixed tumor malignant (clinical)
	54591	28	0	IV	?	R	15 yr.	Died 1 yr. from tumor			Clinical diagnosis					0	Mixed tumor, malignant (clinical)	Mixed tumor malignant (clinical)

ADENOCARCINOMA, SALIVARY GLAND																		
66233	47	?		IV	0	S & R	1 yr.	Died 4 days post-operatively	4	1	Glandular solid masses	4	3	0	0	0	Carcinoma, parotid	Adenocarcinoma, parotid

TABLE I—CONT'D
MALIGNANT MIXED TUMORS

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOUCH)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA								ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS		
86999	16	0	IV	1	S & R	11 yr.	Died 5 yr. postopera- tively of recur- rence	2	3	Glandular, adenocystic	2	0	0	Recur- rence very inv.	0	Adeno- car- cinoma	Malignant mixed tumor
81080	68	8 mo.	I	2 inv.	S & R	2 yr.	Died 2 yr. "heart failure"	4	1	Glandular, chiefly solid masses	2-3	0	0	0	?	Fibro- myxo- car- cinoma	Semima- li- gant mixed tumor
79970	25	0	III	7	S & R	15 yr.	Well 6 yr. to date	4	1	Glandular solid masses	3	1	0	0	0	Myxo- car- cinoma	Malignant mixed tumor
101125	15	6 mo.	IV	3 inv.	S & R	4 yr.	4 yr. to date? re- currence	3	2	Glandular (adenoid), epidermoid carcinoma overgrowth	3	2	0	Salivary gland tissue inv.	0	Mixed tumor with epider- moid carci- noma (bran- chiogen- ic)	Mixed tumor malignant (epider- moid)

HOUCK: TUMORS OF SALIVARY GLANDS—II

TABLE I—CONT'D
OTHER MALIGNANCIES

TABLE I—CONT'D

OTHER MALIGNANCIES

101038	42	0	III	2	S	1 yr.	Well 3½ yr. to date	4	1	Epithelial cells pigmented	3	1	0	Lymph nodes	+	Mela- noma	Pigmented melanoma
84244	65	0	III	3 inv.	S	1 yr.	Died 2 yr. post- opera- tively of tumor	4	1	Epidermoid	4	4	0	Lymph nodes	+	Adeno- car- cinoma, sub- max- illary gland	Meta- static epider- moid carci- noma
44694	22	0	III	0	S & R	2 yr.	No death certificate	4	2	Epidermoid characteristics	3	2	0	Salivary gland	0	Car- cinoma, parotid	Carci- noma, epider- moid?
65011	78	0	III	0	S & R	10 mo.	Died 9 yr. post- opera- tively of tumor of pharynx	4	1	Epidermoid pearls	2	2	0	0	Adeno- car- cinoma	Epider- moid carci- noma	
109874	66	0	II	I	S	8 yr.	Recurred; well 2 yr. to date	4	1	Epidermoid in wall of cyst	3	2	0	0	Branchi- ogenic car- cinoma	Epider- moid carci- noma in cyst	

TABLE I—CONT'D
ADENOCARCINOMA, SALIVARY GLAND

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOUGH)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA								ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS		
30085	62	1 mo.	III	0	S & R	6 mo.	Died 3 yr. from tumor	4	1	Glandular solid masses	4	2	0	Lymph nodes	+	Adeno- car- cinoma, parotid	Adeno- car- cinoma, parotid
52712	45	0	IV	2 inv.	S & R	3 yr.	Died 19 mo. from tumor	3	2	Glandular solid masses	3	2	0	Salivary gland	0	Adeno- car- cinoma, parotid	Adeno- car- cinoma, parotid
98501	56	0	IV	2 inv.	Bi- opsy and x-ray	7 mo.	Well 4 yr. to date	4	1	Glandular, adenoid tendency	2	0	0	0	0	Adeno- car- cinoma, parotid	Adeno- car- cinoma, parotid
50533	40	1 yr.	IV	3 inv.	S & R	15 yr.	Died 6 yr. postopera- tively of tumor	1	3	Glandular, adenoid	2-3	0	0	0	0	Adeno- car- cinoma, sub- maxil- lary gland	Adeno- car- cinoma, noma

TABLE IV
AVERAGES OF CLINICAL DATA FROM TABLE I

REVISED HISTOLOGIC DIAGNOSIS	NO. OF CASES	AVERAGE AGE FIRST NOTICED	AVERAGE PREOPERATIVE DURATION	FACIAL NERVE INJURY OR OTHER OPERATIVE COMPLICATIONS	RECURRENT	DEATH FROM TUMOR	RADIOTHERAPY USED
Benign mixed tumor	25	28 yr.	10.5 yr.	20%†	4%†	0	8%
Malignant mixed tumor	12	35 yr.	9.2 yr.	42%	50%	33%	75%
Adenocarcinoma	5	50 yr.	4 yr.*	60%	60%	80%	100%

*If one exceptional case of 15 years' duration is included, this average would be 13 years.
†Three cases with facial nerve injury were in Houck's Clinical Group III, and two in Clinical Group II.
‡A single patient, on return examination, showed a possible but questionable recurrence in the scar; refused treatment.

In Part I³ it was stated that, in the reviewed literature, the distinction between malignant mixed tumors and pure carcinomas was frequently not clearly defined. The distinction between benign and malignant mixed tumors is also not always defined. The comparative data in Tables II and III, along with Ahlbom's statistics,¹ apparently justify such distinction.

Nevertheless, the fact that all mixed tumors are probably potentially malignant must not be disregarded. In benign mixed tumors in this series, invasion of the capsule by the epithelial element was noted in 28 per cent (Table III) and possibly would have been found in more if the entire specimen had been examined microscopically. This invasive tendency is perhaps of importance in the pathogenesis and clinical behavior of these tumors. There is characteristically a well-defined capsule. There is also a tendency toward reencapsulation of cells which break through the original capsule.¹ Mixed tumors of long standing are of nodular structure most probably develops by invasion of the capsule of the original tumor nodule by growing cells, which, in turn, become encapsulated and form daughter nodules. It seems possible that the expression of potential malignancy becomes evident when the balance between the invasive tendency of the tumor and the encapsulating property of fibrous tissue of the individual host is broken down, with concurrent acceleration of growth. Acceleration of growth following operative trauma may similarly represent a breakdown of this biologic balance by damage to the protective capsule and fibrous tissue barriers. The protective capsule is less prominent in definitely malignant mixed tumors.

TABLE II

TUMOR TYPE	NO. OF CASES	
Mixed tumor, benign	21	
Fibromyxoma, sublingual gland	1	
Chronic inflammation, submaxillary gland	1	
Total benign	26	(54.1%)
Mixed tumor, malignant	12	
Pigmented melanoma	1	
Adenocarcinoma, salivary gland	5	
Epidermoid carcinoma	4	
Total malignant	22	(45.9%)

concept of "relative malignancy" is kept in mind, a semimalignant group as used by Ahlhom should be unnecessary. The terms mixed tumor, benign, and malignant are in common usage. A better terminology for the so-called mixed tumors would be relatively benign and relatively malignant, in view of the potential malignancy of the entire group.

If the malignant and benign mixed tumors are grouped together, the result is 36 mixed tumors, or 75 per cent of the total. If the 6 cases which apparently were not primary salivary gland neoplasms are discarded and the fibromyxoma included, the total is 42 cases with 37 mixed tumors (89 per cent) predominating.

The validity of the revised pathological diagnosis was checked by reference to follow-up statistics (Table IV). Postoperative recurrence was noted in 4 per cent of benign mixed tumors, in 50 per cent of malignant mixed tumors, and in 60 per cent of adenocarcinomas. In no case was there a fatal outcome in the benign group, although in 33 per cent of malignant mixed tumors and in 80 per cent of adenocarcinomas death has resulted from the neoplasm.

TABLE III
HISTOLOGIC CRITERIA*

REVISED HISTOLOGIC DIAGNOSIS	CELLULARITY†	QUANTITY OF STROMA†	ANAPLASIA†	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	ADENOCYSTIC OR CYLINDROMATOUS AREAS	ENCAPSULATION†	CAPSULE INVASED	NORMAL TISSUE INVASED
Benign mixed tumor	2.2	2.8	1.9	4.3%	43%	71%	3	28%	4%
Malignant mixed tumor	3.2	1.9	2.8	50 %	0	33%	2.4	33%	41%
Adenocarci- noma	3.3	1.6	3.2	75 %	0	0	1.4	100%	60%
Other malig- nancies	4	1.2	3	100 %	0	0	1.2	60%	60%

*Averages estimated from Table I.

†Relative figures based on a 1, 2, 3, 4 grading.

3. *Duration of Tumor*.—Although there was little difference in the average preoperative duration of benign and malignant mixed tumors, the duration was much shorter for adenocarcinomas (Table IV). This fact confirms McFarland's⁴ observation that, if a tumor brings the patient to operation within one year of onset with the microscopic picture of carcinoma, the prognosis is ominous.

4. *Acceleration of growth* was about as common in benign as in malignant tumors. In benign tumors this phenomenon possibly represents the formation of new daughter nodules.

5. *Mobility*.—Fixation of the tumor appears to be much more common in malignant tumors and a fairly reliable criterion of malignancy:

NO. OF CASES	FIXED	MOVABLE
Benign	6	20
Malignant	17	5

These figures are in accord with Ahlborn's findings.¹

6. *Metastases*.—Lymph node metastasis was found in a single case of adenocarcinoma and a questionable lymph node involvement in a single case of malignant mixed tumor.

MALIGNANT CHANGE IN MIXED TUMORS

The average preoperative duration of benign and malignant mixed tumors is about the same in this series of cases (Table IV) and in statistics published elsewhere.¹⁻³ Over 50 per cent of the malignant mixed tumors in this series had been noticed from six to twenty-eight years before treatment. Such tumors were probably potentially malignant from the start.

There was no microscopic evidence of a malignant change except in one case (No. 101125), in which an epidermoid carcinoma was present in a tumor which otherwise showed the structure of the more benign mixed tumors and a preoperative duration of six years. Acceleration of growth had been noted for six months.

TREATMENT

Operative excision, partial or complete, was performed in all but three cases. In sixteen cases surgery was supplemented by radiation therapy, in one form or another. Two cases were considered inoperable and were treated by radiation therapy only. In both of these incision was made into the tumor, in one for biopsy and in the other for insertion of radium needles. A single case, in which there was a slow-growing, apparently benign tumor, was not treated at all because of old age and multiple infirmities.

Radiation therapy was applied in the form of high voltage x-ray, both preoperative and postoperative, radium element placed in the

HISTOLOGIC CRITERIA OF MALIGNANCY

An attempt was made to evaluate the histologic criteria of malignancy which have been suggested in the literature. The averaged results are summarized in Table III. Although most of these criteria, as previously stated, must be considered to be of relative importance, if all of them are considered together in a given case, they appear to have definite value in determining the malignancy of the given tumor.

As noted by Stein and Geschickter,⁵ the character of the stroma, particularly the presence or absence of cartilage-like tissue, appears to be a more important criterion than the cellularity or the anaplasia of the epithelium. In Table III the type of epithelium, nuclear changes, and invasion of normal tissue stand out as significant criteria. Normal tissue was invaded in a single case of benign mixed tumor, where a few epithelial cells had penetrated the areolar tissue about a group of blood vessels (Case 121803).

CLINICAL FEATURES

Of the 48 cases studied, there were 25 males and 23 females. In 22 cases the tumor was on the right side of the neck and in 25 on the left side. This even distribution is in accord with published statistics.¹ Thirty-nine were in the region of the parotid; 8, of the submaxillary; and 1, of the sublingual gland. Thirty-three patients (70 per cent) were white and 15 (30 per cent), negroes. At the University Hospital 83.6 per cent of hospital patients are white and 16.4 per cent, colored. Stein and Geschickter⁵ have provided the only other statistics on distribution between the white and negro races and assumed the frequency to be greater among whites. Comparison is given in the table below:

	SALIVARY TUMORS		HOSPITAL ADMISSIONS	
	WHITES	NEGROES	WHITES	NEGROES
Stein & Geschickter	80.1%	19.9%	Not	given
Houck	70.0%	30.0%	83.6%	16.4%

Although the present series is small, when referred to the distribution of whites and negroes in hospital admissions, the distribution of salivary tumors among the two races would appear to be fairly even.

CLINICAL CRITERIA OF MALIGNANCY

1. *Subjective symptoms* were prominent in all of the adenocarcinoma cases, with spontaneous facial paralysis in one. Mild pressure symptoms or mild pain occurred in less than one-half of benign and malignant mixed tumors.

2. *Age of Patient.*—Tumor was first noticed at a somewhat greater average age in the malignant groups (Table IV).

operation, and the other 3 from the tumor after nineteen months, three years, and six years, respectively; mortality was 100 per cent; recurrence, 80 per cent; facial nerve injury, 75 per cent.

A single case was considered inoperable. A biopsy was performed, followed by high voltage roentgen ray therapy. The mass disappeared and the patient has been well four years to date.

In cases treated by surgery combined with irradiation, treatment was of little or no benefit, and possibly was harmful. A single case was effectively treated by irradiation alone.

CLINICAL CLASSIFICATION OF MALIGNANCY AND OPERABILITY

McFarland's⁴ tabulation of salivary tumors as to size and recurrence represents the only previous effort toward formulating a classification based on clinical examination as an index of operability. Ahlbom's principle of therapeutic trial with external irradiation¹ is of aid in determining operability and malignancy, benign tumors being generally more ray resistant.

Tabulation of the tumors in this series after McFarland's method (Table V) confirms his finding that recurrence is frequent when the tumor is removed while small. Facial nerve injury, which was not considered in McFarland's study, was frequent in all groups.

TABLE V

TABULATION OF TUMORS IN THE PRESENT STUDY BY MCFARLAND'S CLASSIFICATION⁴

SIZE	NO. OF TUMORS	FACIAL NERVE PARALYSIS AFTER TREATMENT		RECURRENCE	
Smaller than a walnut	18	4	22%	3	17%
Walnut to lemon size	24	5	21%	8	33%
Larger than a lemon	8	3	37%	2	25%

In Part I³ the need for a satisfactory clinical classification was expressed. Fixation of the tumor was singled out as the most reliable clinical criterion of malignancy. The treatment of malignant tumors by surgery was found to be generally ineffective, at times doing more harm than good. With these facts in mind, all tumors in this study were grouped according to both size and mobility as follows:

Group I Tumors freely movable; size 4 cm. or less in diameter

Group II Tumors freely movable; size larger than 4 cm.

Group III Tumors partly or completely fixed; size 4 cm. or less in diameter

Group IV Tumors partly or completely fixed; size larger than 4 cm. in diameter

The application of this combined method of clinical classification to the present material has resulted in a number of interesting correlations (Table VI).

wound, interstitial radium needles, and radium packs. The methods and dosage were not standardized and were different in nearly every case. In many cases the dosage was rather small in comparison with the more recent radiologic techniques.

RESULTS OF TREATMENT

The results of treatment of salivary tumors in this series parallel fairly closely previously published data with the exception that the recurrence rate was much lower in benign tumors in this series. The results of treatment of malignant tumors in this series are inferior to Ahlbom's results, possibly due to less efficient use of irradiation.

Benign Tumors.—Of 25 cases treated by surgical excision, no patient has died from the tumor and a single possible recurrence is noted. Partial or complete facial nerve paralysis followed operation in 5 cases (20 per cent). Eleven cases were followed for eight years, and 9 cases for ten (Tables I and IV). Supplemental irradiation was used in small doses in only 2 cases, with no significant effect. Surgery in benign mixed tumors in this series has apparently been quite effective in eradicating the tumor, with a very slight risk of recurrence. Nevertheless, a 20 per cent incidence of facial nerve paralysis raises a doubt as to the desirability of surgical treatment. Of 5 cases with facial nerve injury, 3 were small and fixed, and 2, large and mobile. If the 6 benign cases exhibiting fixation are eliminated, the percentage of nerve injury would be 10.5 per cent. No nerve injury occurred in 14 cases, where the tumor was small and mobile, and surgery was effective for the benign tumors in this group.

Malignant Mixed Tumors.—

1. Treated by surgery only, 3 cases: 1 died in 4 months from the tumor; 1 died in 6 years of "psychosis"; and 1 is living and well after 4 years.

2. Treated by radium needles only, 1 patient who died in one year from the tumor; salivary fistula and ankylosis of the jaw followed treatment.

3. Treatment, surgery combined with irradiation, 8 cases: recurrence in 4 (50 per cent); death from recurrence in 2 (25 per cent); death from "heart failure," 2 within four years; living and well, 2, 1 for thirteen years and 1 for six years.

Of the total malignant mixed tumors, death from the tumor followed treatment in 33 per cent, the tumor recurred in 50 per cent, and facial nerve injury or other complication was observed in 42 per cent. The malignancy of individual tumors varies widely. Radiation therapy appears to be beneficial in individual cases.

Adenocarcinomas.—Four of the 5 cases were treated by surgery combined with irradiation. One patient died of embolus four days after

1. Eighty-three per cent of the movable tumors were diagnosed histologically benign.

2. Seventy-four per cent of the fixed tumors were diagnosed histologically malignant.

3. In Group I (small, movable) there was a single possible recurrence (6 per cent). There were no facial nerve injuries and no deaths from the tumor.

4. In Group II (large, movable) there was 1 recurrence (17 per cent), 2 facial nerve injuries (33 per cent), and no deaths from the tumor.

5. In Group III (small, fixed) 62 per cent were microscopically malignant; recurrence occurred in 38 per cent; and nearly one-third of the total have died from the tumor. The percentage of facial nerve injury (54 per cent) is the highest of any group.

6. In Group IV (large, fixed) 90 per cent were microscopically malignant; recurrence occurred in 60 per cent; and 60 per cent have died from the tumor. A high rate of facial nerve injury was sustained (33 per cent). Other postoperative complications included 1 fatal pulmonary embolus, 1 hemiplegia, 2 salivary fistulas, and 1 ankylosis of the jaw.

This clinical classification, based on size and fixation, should be of distinct aid in treatment and prognosis, since: (1) An estimation of malignancy is provided. (2) Preliminary biopsy is avoided. (3) Inconclusive histology can be disregarded. (4) An index of operability is provided, based on the chances of recurrence and operative complications.

In consideration of McFarland's finding that tumors removed while small recurred more frequently, it is of interest to note the effect of the factor of fixation on such statistics. Reference to Table VI shows that, of the total of 47 tumors, 18 were small and mobile (Group I) and 13 small and fixed (Group III). A single possible recurrence was noted in Group I with no facial nerve injury, while in Group III recurrence occurred in 38 per cent and the facial nerve injury rate was 54 per cent. The factor of fixation in 40 per cent of the small tumors possibly accounts for McFarland's findings. When one considers that many of the deeper or fixed neoplasms produce pressure symptoms and probably bring the patient to the surgeon earlier, his findings are plausibly explained.

SUGGESTED PLAN OF TREATMENT

In determining the cases which are suitable for operation, the character of the tumor (benign or malignant), the chance of recurrence, the possibility of facial nerve paralysis, and the possibility of incomplete excision are obviously of importance in making the decision and should be carefully considered. The clinical classification (Table VI) appears to be of value in making the decision.

TABLE VI

CLINICAL GROUP (HOUCK)		HISTOLOGIC DIAGNOSIS										AVERAGE DURATION YRS.	INCOMPLETE EXCISION		PART OR ALL OF SALIVARY GLAND REMOVED		FACIAL NERVE INJURY		OTHER COMPLICATIONS	RECURRENT		DEATH FROM TUMOR
		MIXED TUMOR BENIGN		MIXED TUMOR MALIGNANT		CARCINOMA OR OTHER MALIGNANCY		TOTAL BENIGN		TOTAL MALIGNANT												
		NO.	NO.	NO.	NO.	%	%	NO.	NO.	%	%		NO.	%	NO.	%	NO.	%				
I. Freely movable; 4 cm. or less in diameter		18	14	4*	0	78	22	10.4	0	1	0	0	0	0	0	1	6	0				
II. Freely movable; larger than 4 cm. in diameter		6	5	0	1	83	17	11.8	0	1	2	33	0	0	1	17	0					
III. Partly or com- pletely fixed; 4 cm. or less in diameter		13	5	3	5	38	62	3.6	1	4	7	54	0	0	5	38	4					
IV. Partly or com- pletely fixed; larger than 4 cm. in diameter		10	1	5	4	10	90	10.9	6	2	3	33	3 (Fatal 2)	6	60	6						
Total movable tumors		24	19	4	1	83	17	11.1	0	2	2	11	0	2	11	0						
Total fixed tumors		23	6	8	9	26	74	7.2	7	6	10	43	3	11	49	10						

There are no tumors of sharply malignant mixed tumors since the series were diagnosed as semimalignant in Table I.

*All four of the malignant mixed tumors in Clinical Group I were diagnosed as semimalignant in Table I. There are no tumors of sharply defined histologic malignancy in Clinical Group I. The semimalignant mixed tumors were grouped with malignant mixed tumors since the series is small.

nique (described by Ahlbom¹), surgery may prove to be of value in Clinical Groups III and IV after a preliminary therapeutic trial of high voltage roentgen therapy. The size of the tumor may be decreased by irradiation, and mobility and cleavage may be improved. Tumors which were inoperable by ordinary methods, Hybbinette removed successfully by intracapsular curettage followed by blunt dissection removal of the capsule. Recurrence rate was 4 per cent, and no facial nerve injuries were obtained.

Ahlbom¹ recommends that irradiation be used on all cases, benign or malignant, operable or inoperable. In view of the excellent results reported from his clinic, this recommendation should be given due consideration.

RADIATION METHODS

Radiologic methods are changing so rapidly that any definite statements concerning the proper technique for salivary tumors must be subject to frequent modification. The majority of radiologists at present tend to avoid the use of emanation implants, although in individual cases good results have been obtained in tumors superficially located, particularly in recurrences. Fractional doses of external irradiation, chiefly in the form of high voltage x-ray, are favored in treating most cases. There is some question as to the quantity or total dosage which will give the best results. In this regard the recent publication by Chamberlin and Young² questions the use of the method of Coutard in treating all cases of cancer. These writers believe that tumors which are highly ray resistant possibly may be best treated by smaller doses of radiation, repeated at intervals. Reduction of blood supply and sealing of the lymphatics are said to be the advantage of this plan of treatment, when the epithelium of the tumor is too resistant to be totally destroyed by massive doses. A similar method has been successfully used at the Radiumhemmet for resistant salivary tumors.¹

It is true that most salivary tumors are ray resistant and that the protective fibrous capsule of these tumors is most important in impeding spread of the growth. It is also true that the fibrous and fascial structures of the neck are important in limiting spread of growth, since these tumors spread chiefly by direct local invasion. Realizing that extensive irradiation may damage fibrous tissue, the preservation of fibrous barriers should be considered in radiologic, as well as in surgical, treatment.

The methods used by Ahlbom¹ at the Radiumhemmet are in accord with these principles. Tumors are first given light doses to test the individual sensitivity to the rays; if a marked response is obtained, radiation is continued to the maximum of tissue tolerance. If the response to irradiation is slight, smaller doses are given, repeated at intervals of six weeks or longer. Ahlbom¹ and Stewart⁶ highly recommend

The impression received in the present study is that rapidly growing tumors are usually malignant and that results of treatment of malignant salivary tumors by operation only have been universally unsatisfactory. After growth of a salivary tumor has proceeded to a deforming size, surgical treatment is more difficult and complications and incomplete excision are more frequent. It would appear expedient, therefore, to remove a tumor while small, if the factor of fixation is not present.

As in the treatment of other tumors, treatment of salivary tumors must be individualized, probably to a greater extent than neoplastic diseases of other regions. In selecting cases for operation or irradiation, the clinical grouping (Table VI) is recommended in the hope of decreasing operative complications and the use of surgery where the chance of cure is remote.

Although the present series is small, the striking contrasts between the four clinical groups defined apparently justifies the following general outline of treatment:

Group I (Small and Freely Movable).—All cases should be treated by surgical excision, unless the patient is aged or debilitated and the tumor of long duration with slow rate of growth. A preoperative therapeutic test of high voltage x-ray therapy is optional. If, following surgical excision, tissue section indicates possible malignancy, postoperative irradiation is indicated, either by radium element in the wound or by deep x-ray therapy.

Group II (Large and Freely Movable).—Fractional x-ray therapy is advisable in an effort to decrease the size of the tumor and facilitate operation (Ahlbom). Depending upon the response to irradiation, operative excision should be considered and performed in most instances. The cosmetic deformity of the tumor should be compared with the chance of facial nerve paralysis, which is infrequent in this group. Postoperative irradiation is indicated if the tissue section shows possible malignancy and is optional in benign cases.

Group III (Small and Fixed).—A trial of external irradiation in fractional doses is the treatment indicated. Surgical excision seldom should be attempted (facial nerve injury, 54 per cent; recurrence, 38 per cent), even if there is no response to irradiation. If external irradiation is ineffective and the clinical impression strongly indicates malignancy, interstitial emanation implants may be indicated.

Group IV (Large and Fixed).—External irradiation in a course of fractional doses is the only logical treatment. Implants of emanation should be avoided. Surgery is usually contraindicated (facial nerve injury, 33 per cent; recurrence, 60 per cent).

A possible exception to the above generalizations must be noted. In view of the results obtained by Hybbinette by a special operative tech-

BATHING TRUNK NEVUS

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IN 1917 Heuer reported a case of extensive congenital hairy nevus of the bathing trunk type associated with hematoma of the back and spina bifida occulta. In the same paper he presented 26 cases of bathing trunk nevus collected from the literature* and discussed the features of resemblance between this affection and von Recklinghausen's disease. Heuer's own case was the first reported of bathing trunk nevus associated with spina bifida occulta and hematoma of the back, although a group of related cases with spina bifida and hypertrichosis lumbalis had been described.

It is the purpose of this paper to record 2 cases of bathing trunk nevus seen at the New York Hospital and to review 11 cases found in the literature since 1917. A summary by Reuben in 1928, in which 31 cases were reviewed, included 19 of those mentioned by Heuer and 12 others for which no references were given. The latter 12 are not presented in this report. The total number of cases of bathing trunk nevus reported to date is 40.

The essential physical phenomena of von Recklinghausen's disease are the presence of pigmentation of the skin, cutaneous tumors or fibromas, and tumors of the nerves or neurofibromas. The symptoms include painful cramps, vague disturbances of the sensorium, and progressive loss of intelligence. Of the 27 cases of bathing trunk nevus reported by Heuer, 22 had various forms of pigmentation, 9 had cutaneous tumors, and 1 had neurofibromas.

The additional cases of bathing trunk nevus found in the literature were reported by Voerner, Helle, Cleuet and Ingelbrans, Wise, Siemens and Waardenburg, Reuben, Wiedemann, Lightwood, Bona and Cardenas, Bjorneboe and Andrews. A brief account of these cases will be given first.

CASE 1.—(Voerner, 1905.) This is the report of a female, aged 30 years, who, on examination, showed numerous small skin tumors, some the color of the adjacent skin, others slightly bluish. These tumors were soft and, when depressed, sank into the tissues, only to resume their former shape when the pressure was released. There were several pedunculated tumors, one hanging from the

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*Heuer's cases reported from the literature were those of Walther, Alibert, Kostial, DeAmicis, Hebra, Scarenzio, Michaelson, Jablonski and Klein, Hyde, Variot, Planner, Linke, Eichhoff, Moller, Joseph, Ornstein, Thienel, Rohring, Rossie, Reinhardt (2 cases), Rost, Bonn, Fasal, Fox and "author unknown."

the use of filtered radium capsules placed in the wound at operation. Ahlbom¹ particularly favors application of radium in the wound in benign tumors.

SUMMARY

1. A series of 48 cases of tumors of the parotid, submaxillary, and sublingual glands has been reviewed, particularly in relation to the histologic character, the treatment, and the results of treatment. The latter include recurrence, facial nerve injury, and, in 40 cases, a complete follow-up.

2. From the study of these cases, a clinical grouping has been developed as follows:

Group I Tumors freely movable; size 4 cm. or less in diameter

Group II Tumors freely movable; size larger than 4 cm.

Group III Tumors partly or completely fixed, size 4 cm. or less in diameter

Group IV Tumors partly or completely fixed; larger than 4 cm. in diameter

3. A general program for the treatment of cases in each of the four clinical groups is suggested.

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the rest of the tumor. Small tumors were palpable on the abdomen. Abnormal pigmentation extended over the abdomen and the thighs. A few tumors were present over the face and the scalp. No neuromas were palpable. The child's growth had been normal for his age. When the child was 9 months old, the tumor

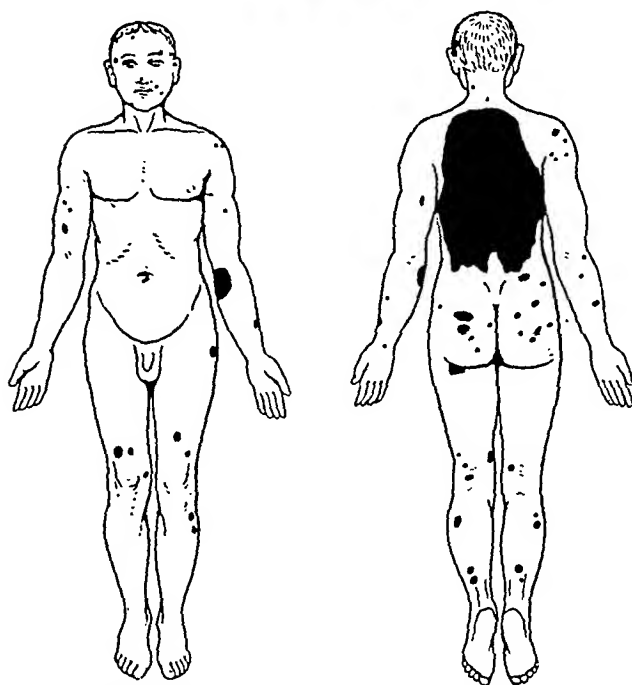


Fig. 2.—Case 5 (Siemens and Waardenburg). Identical male twins, 13 years of age. The one with the large hairy nevus over the back had sixty-two other hairy nevi over the body. The other twin had only one nevus, which was on the face and nonpigmented.

of the scrotum was removed. The tissues were not unusually vascular and the operation was performed without appreciable loss of blood. The testicles were found in their normal position. At 11 months of age, the child was in perfect health.

shoulder halfway down the arm. There was a definite abnormality of the distribution of pigment. Many pigmented spots were present over the body, and, below the level of the umbilicus, these were confluent, forming an extensive pigmentation which reached from the fifth vertebra on the back and the umbilicus in the front down to the thighs. This region had the appearance of a bathing trunk.

CASE 2.—(Helle, 1922.) (Fig. 1.) This is the report of an infant, 10 months old, the third child of parents aged 31 and 33 years. The child was strong, healthy, and active. The skin over the anterior and posterior surfaces of the body in an area arching from the right shoulder to the left groin was dark brown in color. Some portions of this area were only lightly pigmented; others were covered with dark brown hairs, especially thick about the shoulder and measuring up to 10 cm. in length. Over the right nipple hung a broad fibrolipoma about the size of a child's fist; two others resembling potatoes were in the dorsal midline at the same level. On the blond head of the child were numerous irregularly scattered brown hairy nevi, "ranging in size from that of a pea to that of a five mark piece." Similar tumors were seen on both cheeks and on the right temple. The extremities down to the toes and fingertips were dotted with brown nevi of varying size. The unusual mottled appearance of the hair was changed to uniform blond by the use of peroxide. The nevi of the face were treated with carbon dioxide snow. The larger tumors were excised.



Fig. 1.—Case 2 (Helle's case). A 10-month-old infant with a large, hairy nevus almost completely covering the torso and extending down over the thighs. Note the tumor near the right nipple.

CASE 3.—(Cleuet and Ingelbrans, 1923.) This is the record of a small child with a voluminous tumor of the scrotum, many smaller tumors, and abnormal pigmentation of the skin present since birth. There was no family history of similar tumors. The child was the youngest of nine children, all normal births. The parents reported little change in the tumor except that the broad pedicle to which it was attached had become elongated and smaller in circumference, allowing the tumor to hang down to the knees. This pedicle was attached to the perineum in the region of the anus. The tumor was "waxy" in consistency with occasional areas of harder substance. It measured 9 cm. in vertical direction, 11 cm. transversely, and 9 cm. anteroposteriorly. The entire cutaneous surface was very furrowed and roughened. One portion, the size of a nut, seemed independent of

over the ilium and the other over the left shoulder. The inguinal glands on both sides were definitely enlarged and hard. No other glandular enlargement was noted. The left knee showed signs of hydroarthrosis. X-ray showed that the bones were not diseased. One of the fluctuating masses had been aspirated by another physician who reported that it contained blood. There was no melanin in the urine.

CASE 7.—(Wiedeman, 1930.) This brief report describes a 15-year-old girl who had had, since birth, a hairy, pigmented nevus covering the entire abdomen and back, beginning at the fifth thoracic spine and extending down to the knees. It was dark brown in color. No other details were given in the report.

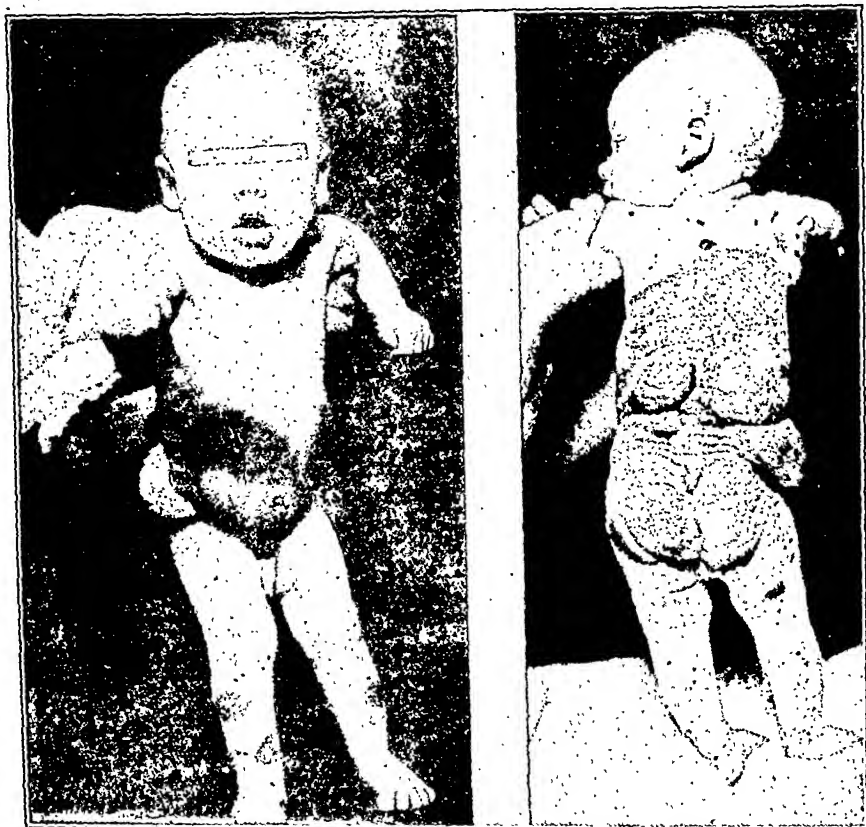


Fig. 4.—Case 8 (Lightwood). Large, hair-bearing nevus of the bathing trunk type with associated tumors (lipomas, neurofibromas). Infant, 8 months of age.

CASE 8.—(Lightwood, 1932.) (Fig. 4.) This is the report of a male infant, 8 months of age, apparently in good health, the only child of normal parents. The skin of the abdomen, back, and buttocks was deeply pigmented and in some areas was covered with fine hair. The condition had been noted at birth. The lesion was roughly symmetrical. There were several small pigmented moles on the scalp and legs. Under the pigmented skin of the back and abdomen were a number of tumors varying in size. The author reported some as firm, possibly neurofibromas; others as soft and lobulated, probably lipomas. No neurologic signs or symptoms were found. The tumors were not examined histologically. (In a discussion Dr. Parkes Weber said that he thought that the main feature of the case was a "pigmented nevus of bathing drawers distribution." It was his opinion that the hard subcutaneous nodules were neurofibromas of true von Recklinghausen's disease.)

CASE 4.—(Wise, 1924.) This is the report of a 19-year-old girl who presented a bathing trunk type of nevus involving the body and thighs down to the knees and reaching up to the second dorsal spine. The lesion had been present since birth. At the back of the hips there was a mass the size of a coconut. On the right hip there was an extensive lipoma with smaller lipomas, the size of olives, lying underneath. On the left side there was a lipoma the size of an orange. Numerous pigmented nevi were situated on the face, trunk, and extremities. There were some keloids on the chest, the result of caustic applications. There were numerous pits on the face.

CASE 5.—(Siemens and Waardenburg, 1927.) (Fig. 2.) The authors report identical male twins examined at the age of 13 years. Both had fiery red hair, pale blue eyes, and light complexions. Both boys were freckled and were strikingly similar in appearance and in stature. Examination showed that one of them had a very large nevus covering the back. It extended from the lower cervical spine to the sacrum. It measured 22 cm. in breadth and 30 cm. in length. Over this region there was deep pigmentation and dense growth of blond hair. Sixty-two other nevi were scattered over the body. The other twin had only one nevus, the size of a pea, on his face. This was pedunculated, hard, hyperemic, and not pigmented.

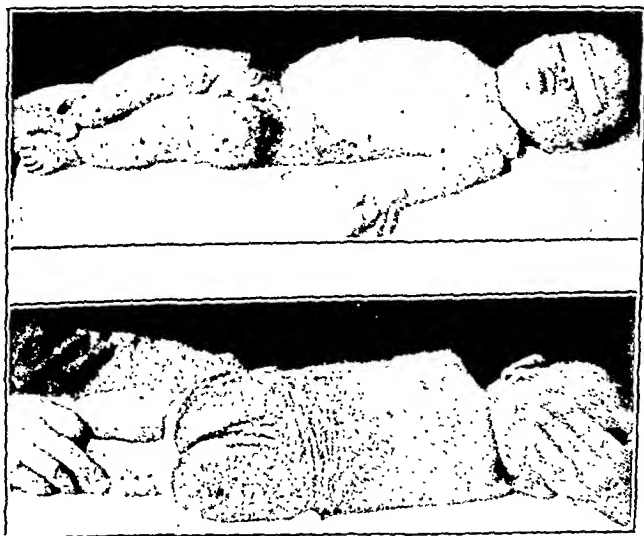


Fig. 3.—Case 6 (Reuben). Six-month-old infant with large pigmented nevus of bathing trunk type. Five hundred and eight pigmented spots were scattered over the body.

CASE 6.—(Reuben, 1928.) (Fig. 3.) This is the report of a male child, aged 6 months, whose parents noted that the child did not move the right leg. Physical examination revealed a large hairy pigmented nevus of the bathing trunk type. The general appearance of the child was normal; at 6 months of age, the child weighed 16 pounds. The anterior fontanel measured $1\frac{1}{2}$ by $1\frac{1}{2}$ inches; no teeth had erupted; the liver was large and its edge was felt two fingerbreadths below the costal margin; the spleen could not be felt. The genitals were not abnormally pigmented. Five hundred and eight pigmented spots were scattered over the body. These varied in size. They were not hair-bearing. The distribution of these spots was as follows: 106 on the head; 200 on the arms; 70 on the chest; 51 on the right leg; 80 on the left leg. There were two nonfluctuating masses present, one

NEW YORK HOSPITAL CASES

CASE 1.—D.D.* (N. Y. H. History No. 198215) Fig. 8 shows a 2½-year-old female child, admitted to the New York Hospital on Jan. 20, 1915, with the chief complaint of a "lump between the legs." The patient's mother stated that at birth a small lump was noted on the right vulva and that this had gradually increased in size. There was no pain but the presence of the mass was annoying and its gradual increase in size caused concern. Past history and family history were not remarkable.

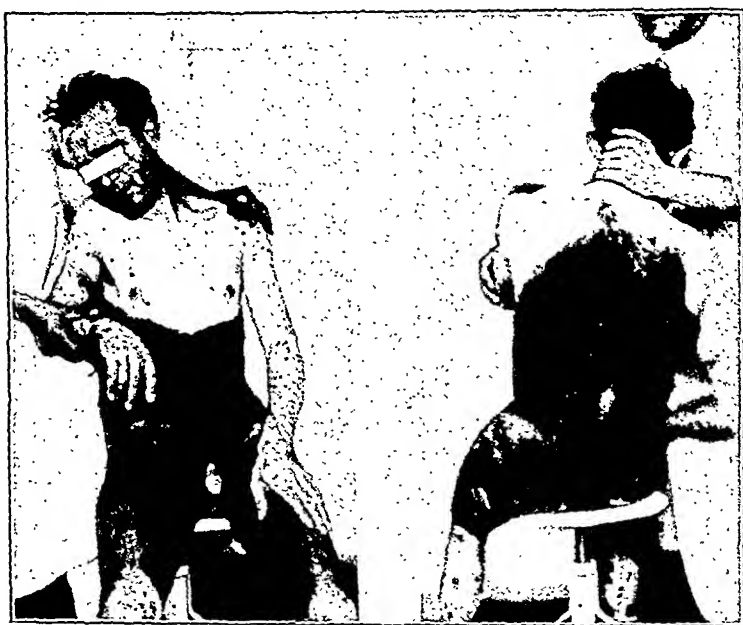


Fig. 6.—Case 10 (Bjornboe). A 37-year-old male with a large hairy nevus of the bathing trunk type, neurofibromas, other pigmented nevi, and melanosarcoma of the brain.

General examination showed that the child was well-developed and nourished, approximately normal in height and weight for her given age of 2½ years. She was normal in intelligence. Interest centered on the examination of the skin. At once evident was an extensive area of dark brown pigmentation, covering the lower thoracic region, the abdomen, buttocks, perineum, and right thigh. Roughly, its distribution corresponded to that of the well-known bathing trunk nevus. The skin over the pigmented areas was roughened, coarse, and covered with fine, long brown hairs. The skin elsewhere was of light color, numerous hair-bearing pigmented nevi being present over the neck, shoulders, and all extremities. These varied in size from minute areas of dark brown pigmentation to larger areas measuring 3 to 4 cm. in diameter. Other than the pigmented nevi, no tumors of the skin were found. There were no neuromas. Examination of the perineum showed that from the suprapubic region and the right labium majorem there hung a mass of soft tissues over which the skin was greatly thickened, corrugated, and scaly. The mass was freely movable but not compressible. It hung 5 cm. below the left labium. At the operation performed by Dr. Eugene Pool on Jan. 26, 1915, considerable hemorrhage was encountered in the excision of the mass. Pathologic report of examination of tissue removed was that of "elephantiasis vulvae." The patient made an uneventful convalescence.

*This case report included through the kindness of Dr. Eugene H. Pool.

CASE 9.—(Bona and Cardenas, 1934.) (Fig. 5.) The authors briefly record the history of a 27-year-old male with a bathing trunk nevus as shown in Fig. 5. The lesion was hyperkeratotic, pigmented, and hairy. There were raised tumors on the legs and forehead. The history was not remarkable. Photomicrographs of sections taken from some of the tumors led the authors to the opinion that the patient did not have true Recklinghausen's disease.

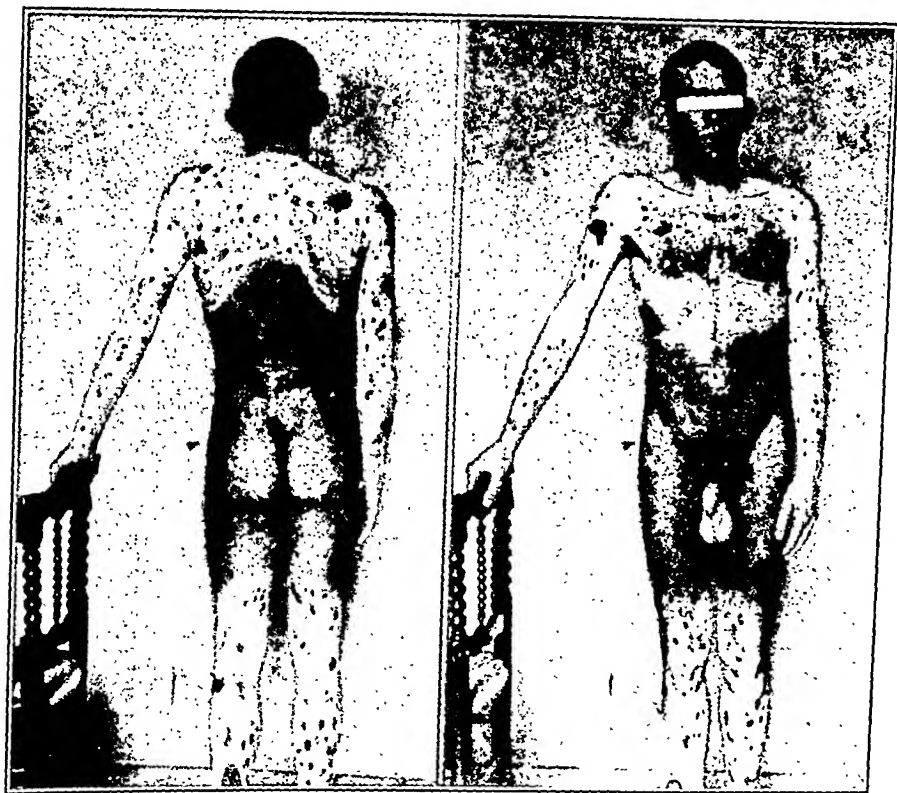


Fig. 5.—Case 9 (Bona and Cardenas). Bathing trunk type of hairy nevus occurring in a man 27 years of age in association with a great number of other hairy pigmented nevi.

CASE 10.—(Bjornboe, 1934.) (Fig. 6.) The author presents the case of a 37-year-old male with primary melanosarcoma of the brain, numerous pigmented nevi of the skin, bathing trunk nevus, and many neurofibromas of the subcutaneous nerves. The patient died after an illness of several months with symptoms of rapidly growing intracranial tumor. The complete autopsy diagnosis was as follows: melanosarcoma in the right hemisphere of the brain; countless pigmented nevi of the skin; hypostasis of the lower lobes of both lungs. The skin of the face and extremities showed innumerable brown spots "ranging in size from that of a pea to that of a penny," most of them quite hairy, only a few elevated above the surface. The trunk and thighs were covered with a furry coat of hair. There was elephantiasis of the skin over the buttocks.

CASE 11.—(Andrews, 1938.) (Fig. 7.) This is a brief report of a case of the bathing trunk type of nevus in an adult male, again associated with areas of pigmentation of the skin.

R. B. C., 6,500,000; W. B. C., 7,750. Differential count was not remarkable. The skin over the face and extremities was of light brown pigmentation, while that of the abdomen and thighs was replaced by a giant hairy nevus, the surface of which was dry, cracked, and furrowed. The nevus uniformly covered an area starting at the fourth dorsal spine posteriorly and at a line traversing the upper abdomen diagonally and extending down to the knees on both sides. The penis and scrotum were involved in the large mole. Separation of the buttocks showed the presence of numerous dry excoriations of the surface of the skin which bled easily.

Over the face and extremities there were numerous pigmented nevi, some flat and nonhair-bearing, others elevated and hairy. These varied in size as shown in the illustrations. Over the arms and legs a few subcutaneous nodules were palpated. These were freely movable and did not have the characteristics of neuromas. On March 10, 1936, one of the pigmented moles was excised from the abdomen, and a circumcision was done. The child showed no tendency to hemorrhage. Pathologic examination of the nevus was reported as follows: "Examination of sec-



Fig. 8.—(New York Hospital, Case 1.) A female child, 2½ years old, with large pigmented, hair-bearing nevus of the bathing trunk type and elephantiasis of the labium.

tions of the tumor of the skin showed it to consist of epithelium which contained a considerable amount of melanin. Beneath the epithelium was dense fibrous tissue in which there were lymphoblasts and melanophores (pigmented macrophages). Just below the epithelium there were large islands of pigmented cells in alveolar formation. All the cells appeared to be well differentiated and without evidence of malignant change." X-rays of the spine and of the long bones failed to show any evidence of spina bifida or other abnormality.

The child has been followed regularly in the Out-Patient Dispensary of the New York Hospital. He is now 3 years old. He has had repeated colds, one attack of tonsillitis. The child was admitted to the hospital in May, 1936, because of bleeding from the cutaneous excoriations about the buttocks. This condition

This child's case was followed for five years. There was no recurrence of the mass, and her growth rate was normal. Photographs of this patient are shown in Fig. 8.

CASE 2.—N. C. (N. Y. H. History No. 123915) (Figs. 9 and 10). This is the report of double ovum, male twins, one of whom exhibited a typical bathing trunk nevus. The negro parents were in good health. A Kline test from the mother was negative. There had been one previous pregnancy. Family history was otherwise negative. The mother was 28 years old and the father 29. The mother had a rather marked anemia during the pregnancy. At birth one infant



Fig. 7.—Case 11 (Andrews). Bathing trunk nevus in association with other smaller nevi.

was noted to have extensive pigmentation of the skin. During the day a weeping excoriation of the skin about the anus of this infant was noted. The anterior fontanel measured 2 by 2 cm.; the posterior fontanel was closed. The head was symmetrical. Examinations of the eyes, ears, nose, pharynx, neck, thorax, heart, and lungs were negative. There were some pigmented spots on the gums. The spine, extremities, and genitals appeared normal. Reflexes were equal on the two sides. Urinalysis was negative. Blood findings: hemoglobin, 22 gm., 100 per cent;

of the 40 cases. These were reported as such whether they occurred over the area of the bathing trunk nevus or elsewhere on the body. In many of the case reports information was not given as to the type of tumor. In others the clinical description of the tumor was set down, but no data as to histologic type were given. It is clear from the records that 7 of these 40 patients had cutaneous tumors of the fibroma molluscum type; 8 were reported as having lipomas or fibromas; 6 had peduncu-

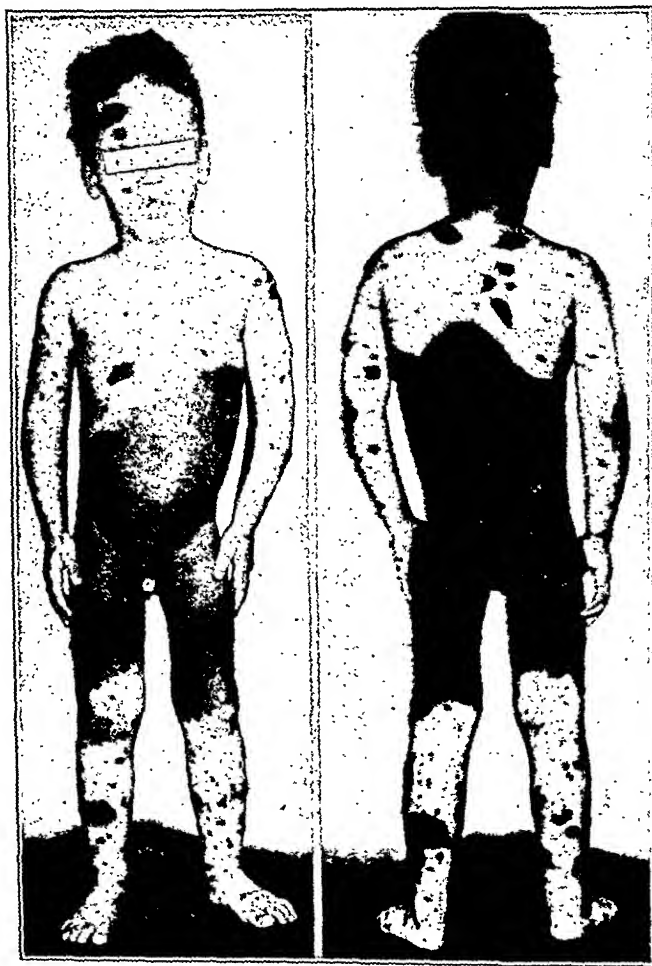


Fig. 10.—(New York Hospital, Case 2.) The same patient as shown in Fig. 9. Photograph taken when child was 2½ years old. Note the underdevelopment of buttocks and left thigh.

lated tumors similar to the pachydermatocoeles of von Recklinghausen's disease; 2 had neurofibromas in association with the giant nevus. There was malignant degeneration of the tumors in only 4 cases (10 per cent). Of these, 2 (cases of Jablokoff and Klein and of Bjornboe) were found to have melanosarcoma of the brain. One case was that of a 6½-month-old infant who had a melanotic sarcoma within the area of the bathing

rapidly cleared up. In 1936 and 1937 some observers described a mass approximately 5 to 6 cm. in diameter overlying the flare of the left ilium. In 1937, as the child began to walk, a definite limp was in evidence. The left foot was turned slightly outward and the left leg dragged. Moderate scoliosis of the spine with convexity to the left in the thoracic region and to the right in the lumbar region was noted. There was asymmetry of the buttocks and thighs with apparent absence of the left gluteus maximus muscle and atrophy of the muscles of the thigh on the left. The mass previously described near the left ilium was no longer in evidence. X-rays of the spine and pelvis taken in June, 1938, showed no abnormalities other than the mild scoliosis noted above. The circumference of the right thigh was 23 cm., while that of the left was 21 cm. Both calves measured 19 cm. in circumference. The child has shown no evidence of mental retardation. Photographs taken at the age of 2½ years are shown in Fig. 10. The other twin is an apparently normal and healthy child.

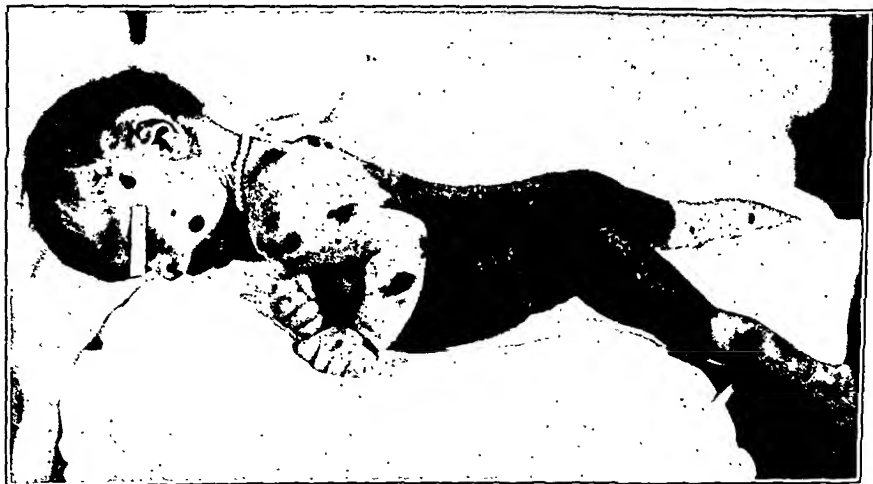


Fig. 9.—(New York Hospital, Case 2.) Infant, one of double ovum twins, showing extensive bathing trunk nevus and other smaller pigmented nevi.

A consideration of the particular features of these striking birth anomalies is interesting. It has been pointed out by others that patients who have a bathing trunk type of nevus may have many of the features of von Recklinghausen's disease. In all of the 40 cases of bathing trunk nevus reported herein, the condition has been congenital. Regarding heredity it may be stated that in 25 of the 40 cases, the history of a similar lesion in the family was not within the memory of those from whom the information was obtained. In all of the cases the distribution of the giant nevus corresponded in its upper dorsal limitations to the direction of Langer's lines of elasticity of the skin. Anteriorly and over the inferior demarcations of the nevi this correspondence was not so marked. In 33 of the cases the giant nevi were covered with hair, fine or coarse, long or short. In the other 7 cases the presence of hair on the large nevi was not mentioned. Accessory pigmentation of varying degree was common to 33 cases. In one patient, 508 areas of pigmentation were counted. Cutaneous tumors were recorded in all but 4

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trunk nevus and multiple melanotic metastases to the brain. Bjornboe's case was recorded as a primary melanosarcoma of the brain, no evidence of malignant change having been found in the large nevus or in the smaller cutaneous pigmented areas. Autopsy reports were given in only three of the entire group of cases. Atrophy of tumors, as known to occur in von Recklinghausen's disease, was recorded in only one case. The secondary symptoms of that disease, the vague functional, vasomotor, and trophic disturbances, have been reported in only a few instances. Associated congenital anomalies have not been prominent, though hypertrophy of the bones of the skull, prognathism, high palatal arch, and spina bifida have been noted. Heuer's case is the only case of bathing trunk nevus known to have an associated spina bifida. However, this anomaly might escape notice unless x-ray pictures were taken. Several reports have called attention to a "depression" of the spinous processes of the vertebrae and one to a scoliosis of the thoracic and lumbar spine. Meningocele has been associated in only one case. Evidence of hemorrhage into the cutaneous tumors, a significant complication of the tumors of von Recklinghausen's disease, was a complicating factor in the removal of a large tumor in one case. In the case of Cleuet and Ingelbrans a large pedunculated tumor was excised "bloodlessly," while in one of the New York Hospital cases the excision of a similar tumor was complicated by brisk hemorrhage. In one other (New York Hospital, Case 2) minor surgery (circumcision and excision of mole) was not complicated by a tendency to hemorrhage. It is interesting that the case reported by Siemens and Waardenburg should have occurred in one of identical twins, while New York Hospital, Case 2 occurred in one of double ovum twins. In the former case the lesion might be classified more accurately as a vest type of nevus rather than a bathing trunk type. Little is recorded in the literature regarding the vest type of pigmented nevus. Reubens reproduced a photograph of a child with this lesion, stating that it was the only one of its kind in the literature up to that time (1928). Andrews has since reproduced a photograph of a child with a vest type of nevus.

In summary it may be stated that there are 40 authentic case records of congenital hairy nevus of the bathing trunk type, the analysis of the reports pointing to the similarity of features of these subjects and those having true von Recklinghausen's disease.

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however, attempts at dilatation are unsuccessful and the patient's condition during this period becomes so poor that quicker and more radical methods of relieving the situation are necessary. The literature contains reports of cases where constricting lesions near or at the cardiac end have been handled successfully by incising the hypertrophic or fibrotic portion down to the mucous membrane. This is an operation similar to that of Ramstedt for congenital pyloric stenosis. Usually, however, these patients are not in condition to undergo any extensive reconstructive work on the esophagus, and it is necessary to employ palliative methods of relief until permanent measures can be safely carried out. The case here presented is most unusual in that what was intended to be a palliative preliminary measure proved to be all that was necessary, because the obstruction of the esophagus, which was almost complete at the time of the gastrostomy, after several months began to disappear spontaneously in much the same mysterious fashion that it came.

When stenosis is of such a degree that it is impossible for the patient to take sufficient quantity of food, gastrostomy is a life-saving measure. There are many types of gastrostomy, but the ideal one is that which provides a permanent opening into the stomach which does not tend to close, which does not leak, and which affords opportunity for retrograde instrumentation. It, therefore, must be lined by mucous membrane rather than serosa and must have some sort of valvelike mechanism at the point of outlet from the stomach. The method devised by Spivak,³ of Chicago, fulfills all of these requirements in a very satisfactory manner.

A case which illustrates this condition very well is that of R. B., a 27-month-old colored female child, who was admitted to our ward at the Cook County Hospital on Feb. 1, 1936. Her history revealed good health until three months previous to admission, at which time she had whooping cough accompanied by considerable vomiting. Subsequently the vomiting became progressively more frequent and she experienced increasing difficulty in taking both liquid and solid food. In fact, during the month preceding her admission to our ward she was unable to keep down even milk. Consequently she lost much weight.

On examination we found a child markedly emaciated and smaller in size than normal. Otherwise there were no positive abnormal findings. The skin was in good condition and there was no evidence of rachitis. Wassermann and tuberculin tests were negative. X-ray films of the chest showed the lung fields and mediastinum to be normal.

A barium mixture was given by mouth and roentgenologic examination revealed a stricture of the esophagus (Fig. 1) at about the level of the seventh thoracic vertebra. Above the point of narrowing, the esophagus was markedly dilated and beyond it a thin stream of barium could be followed about $2\frac{1}{2}$ inches before it entered the stomach. When more barium was given, she regurgitated the entire amount above the stenosis.

The child was given a good quantity of dextrose intravenously and by mouth frequent small feedings of nourishing liquids. Only a small amount of food taken, however, passed beyond the stricture, the remainder being regurgitated a short while after being swallowed. Esophagoscopy revealed a narrowing the size of a

ESOPHAGEAL STENOSIS

SPONTANEOUS STRICTURE IN A YOUNG CHILD FOLLOWED BY SPONTANEOUS OPENING ONE YEAR AFTER TUBOVALVULAR GASTROSTOMY

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ESOPHAGEAL stenosis occurs most commonly at the sites of normal anatomic narrowing which are located, first, at the cricoid cartilage at the level of the fifth cervical vertebra; second, at the crossing of the left main bronchus at the level of the fourth thoracic vertebra; and third, at the esophageal hiatus of the diaphragm level with the tenth thoracic vertebra. Stenosis at other points is quite uncommon, except when due to a malignant growth. One case occurring at the level of the seventh rib is recorded.¹

The causes leading to stenosis, other than carcinoma, at times may be very obscure, especially when there is no history of swallowing of foreign bodies or corrosive fluids. Congenital malformations, such as atresia, with or without tracheal fistula, complete membranous obstruction (membranous diaphragm), and short esophagus with partial intrathoracic stomach, are frequent causes. Those due to neurologic disturbances are achlasia, cardiospasm, and globus hystericus. Benign tumors include polyp (sessile or pedunculated), lipoma, fibroma, leiomyoma, rhabdomyoma, and angioma. Ulcers may be typhoid, syphilitic, tuberculous, actinomyotic, blastomyotic, or peptic. Inflammatory processes resulting from the swallowing of corrosives are well known, but those which may follow acute infections (diphtheria, etc.)² deserve careful attention. Likewise, stenosis may be caused by foreign bodies, arteriosclerosis, varicosities, hyperkeratosis, avitaminosis, and aneurysms. In addition, prolonged physiologic dysfunction in time may produce structural changes leading to stenosis. It seems to us quite likely that some degree of narrowing of the esophagus follows in the wake of the more common acute infections with sufficient frequency to warrant giving careful consideration to the probability of a preceding whooping cough or diphtheria as the etiologic factor in those cases where neither the history nor physical findings give one any other clew. At least our experience seems to warrant this contention.

TREATMENT

All available conservative methods of treatment, of course, should be tried first and surgical interference resorted to only when other measures fail. Repeated dilatation frequently brings relief. In certain cases,

however, attempts at dilatation are unsuccessful and the patient's condition during this period becomes so poor that quicker and more radical methods of relieving the situation are necessary. The literature contains reports of cases where constricting lesions near or at the cardiac end have been handled successfully by incising the hypertrophic or fibrotic portion down to the mucous membrane. This is an operation similar to that of Ramstedt for congenital pyloric stenosis. Usually, however, these patients are not in condition to undergo any extensive reconstructive work on the esophagus, and it is necessary to employ palliative methods of relief until permanent measures can be safely carried out. The case here presented is most unusual in that what was intended to be a palliative preliminary measure proved to be all that was necessary, because the obstruction of the esophagus, which was almost complete at the time of the gastrostomy, after several months began to disappear spontaneously in much the same mysterious fashion that it came.

When stenosis is of such a degree that it is impossible for the patient to take sufficient quantity of food, gastrostomy is a life-saving measure. There are many types of gastrostomy, but the ideal one is that which provides a permanent opening into the stomach which does not tend to close, which does not leak, and which affords opportunity for retrograde instrumentation. It, therefore, must be lined by mucous membrane rather than serosa and must have some sort of valvelike mechanism at the point of outlet from the stomach. The method devised by Spivak,³ of Chicago, fulfills all of these requirements in a very satisfactory manner.

A case which illustrates this condition very well is that of R. B., a 27-month-old colored female child, who was admitted to our ward at the Cook County Hospital on Feb. 1, 1936. Her history revealed good health until three months previous to admission, at which time she had whooping cough accompanied by considerable vomiting. Subsequently the vomiting became progressively more frequent and she experienced increasing difficulty in taking both liquid and solid food. In fact, during the month preceding her admission to our ward she was unable to keep down even milk. Consequently she lost much weight.

On examination we found a child markedly emaciated and smaller in size than normal. Otherwise there were no positive abnormal findings. The skin was in good condition and there was no evidence of rachitis. Wassermann and tuberculin tests were negative. X-ray films of the chest showed the lung fields and mediastinum to be normal.

A barium mixture was given by mouth and roentgenologic examination revealed a stricture of the esophagus (Fig. 1) at about the level of the seventh thoracic vertebra. Above the point of narrowing, the esophagus was markedly dilated and beyond it a thin stream of barium could be followed about $2\frac{1}{2}$ inches before it entered the stomach. When more barium was given, she regurgitated the entire amount above the stenosis.

The child was given a good quantity of dextrose intravenously and by mouth frequent small feedings of nourishing liquids. Only a small amount of food taken, however, passed beyond the stricture, the remainder being regurgitated a short while after being swallowed. Esophagoscopy revealed a narrowing the size of a



Fig. 1.—Esophageal stenosis.

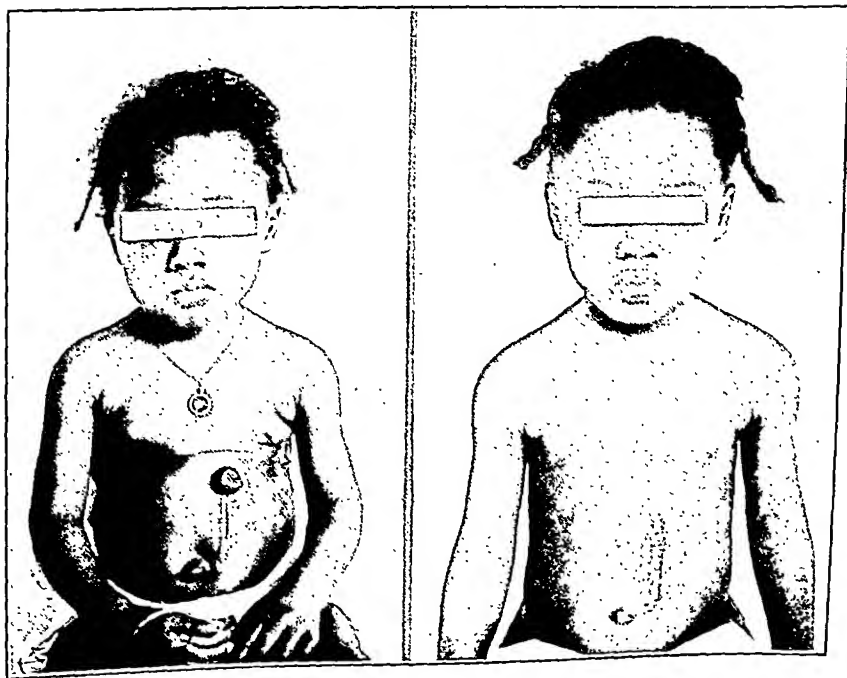


Fig. 2.

Fig. 3.

Fig. 2.—Showing gastrostomy opening.

Fig. 3.—About four and one-half months after closure of gastrostomy.

matchhead about half-way down and several attempts to pass a bougie failed. Likewise, many attempts to have her swallow a string were unsuccessful, and it finally became necessary to proceed with a gastrostomy. This was done April 9, 1936, using the Spivak tubovalvular method.³ The approach was made through the left rectus and the mucus-lined tube brought to the surface at the upper end of the incision near the costal margin (Fig. 2).

The postoperative course was very smooth. On the fifth day a small catheter was passed into the stomach and small amounts of water and milk were given. The quantity was increased each day and gradually puréed vegetables were added to her diet. She gained rapidly in weight and strength. The wound healed without infection. About the margins of the everted mucous membrane a small amount of skin irritation occurred, but it was easily controlled by the application of heavy magnesium oxide, and before long only a strip of vaseline gauze was needed to protect the skin from the action of the gastric juice secreted from the lining of the tube. It was interesting to note that the sphincter-like action at the base of this tube was so perfect that even after large feedings no amount of activity or change in position resulted in a spill and this fact was accurately verified by the x-ray after adding barium to the food.

The child gained in health rapidly and to the surprise of everyone it was noted that in March, 1937, almost a year after the gastrostomy was performed, she was able to swallow and retain considerable liquid food. It soon became easy to pass a small catheter into her stomach, and, also, barium given by mouth no longer accumulated above the point of obstruction. In other words, the stenosis, which upon her admission to the hospital and for eleven months thereafter had been almost complete, had gradually opened up spontaneously, permitting the patient gradually to resume her normal method of taking food. On Sept. 8, 1937, one and one-half years after her operation, she returned to the hospital, fat and strong, for closure of the abnormal opening into her stomach. Since then she has been frequently observed and her progress has been very uneventful (Fig. 3).

COMMENT

Even in a small stomach it is possible in constructing this type of gastrostomy to form a mucous membrane-lined tube of sufficient strength and diameter to function adequately. The base of the flap in the anterior wall of the stomach may be either toward the lesser or greater curvature. The two most essential points in the technique are (1) the formation of the fold to act as a valve at the base of the tube and (2) the construction of the reinforcing cuff which gives it the sphincter-like control. This area is the weakest point and the place where leakage is most apt to occur, hence the necessity for very careful placing of the sutures, without penetrating the mucosa or interfering with the blood supply.

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A SIMPLIFIED BLOOD TRANSFUSION SET

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FOR the past eighteen months we have been using an inexpensive, indirect transfusion set which eliminates pouring of blood, keeps it mixed, filters it as given, and readily shows the rate of flow.

Donor's Set (Fig. 1, 1).—A standard 1,500 c.c. flask with overlapping stopper provided with two tubes is used to collect the blood. One tube is connected to a venepuncture setup and the other is joined to a suction pump. Sodium citrate (2.5 per cent) and then blood are drawn into the flask. The rubber stopper then can be easily removed aseptically. The mouth of the flask is then covered by a second stopper or sterile gauze sponge until the blood is given.

Recipient's Set (Fig. 1, 2).—This consists of a stopper with air vent, filter and tubing attached. The vent is an ordinary 20 c.c. soft glass pipette cut off and bent as shown. The filter is a 25 mm. glass laboratory funnel bent in on one side to permit complete emptying of the flask. Gauze filters are stretched over this and over the long end of the air vent.

This set is wrapped in a shallow pan to prevent breakage.

Giving the Blood (Fig. 1, 3).—The recipient's set is attached to the blood flask by inserting the special stopper. The tubing is clamped and the flask inverted into a C-shaped ring clamp attached to a standard. Bubbles in the tubing are to be avoided. This is done by holding the tubing high, opening the clamp, and then slowly lowering the tube as it fills. Semitransparent gum rubber tubing is used. A three-way valve is employed to attach syringe and needle for venepuncture.

As blood flows, the level slowly falls in the side arm, or vent, which empties and refills as each 5 or 6 c.c. of blood passes to the patient. This allows the same volume of air to bubble up through the blood for mixing. The side arm, then, is a delicate indicator of blood flow. The time required for it to empty, of course, gives the rate of flow. This is advantageous because with many sets it is difficult to estimate the rate of flow or even to decide if the blood is flowing at all.

Used With Saline Solution or Glucose.—We prefer to give fluids with blood usually, and now always employ the recipient's set shown in Fig. 1, 4. The glass plunger can be attached to standard solution flasks used in the hospital. After applying clamps to both tubes, the blood and solution are inverted together with the latter at a higher level (Fig. 1, 5).

The tubing is first filled with saline solution, after which a small volume is allowed to flow into the blood flask to displace the air between the Y-tube and the blood flask. Blood or saline solution can then be given to the patient.

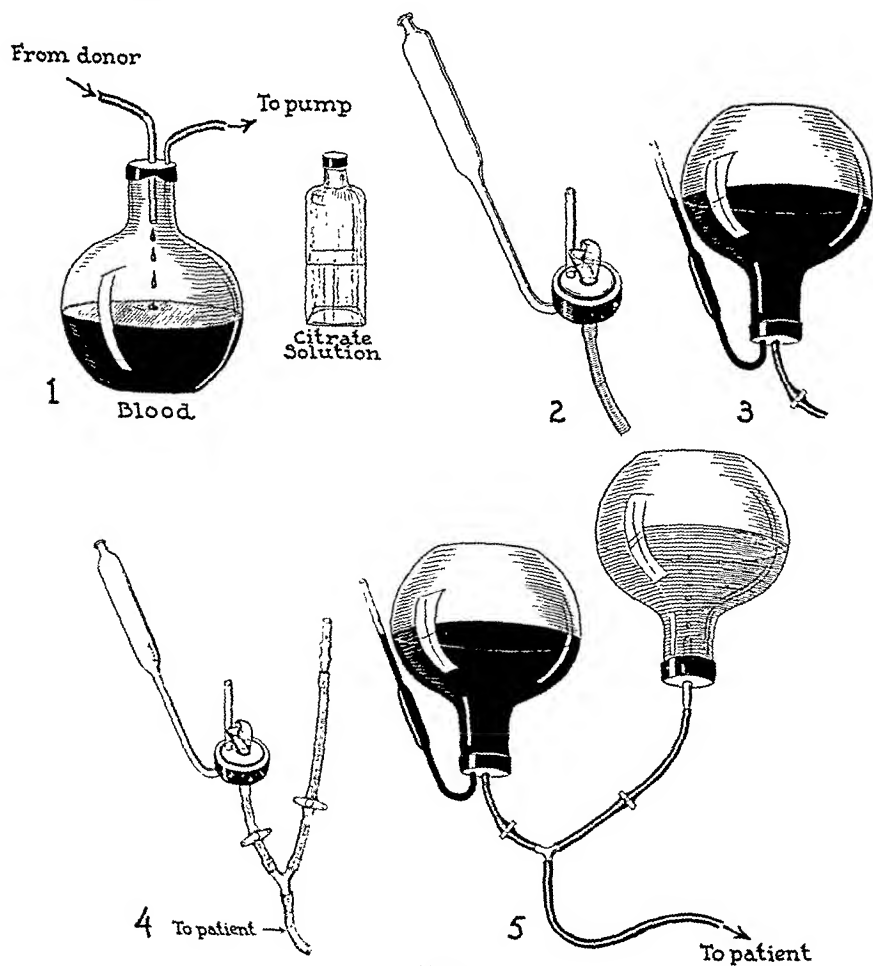


Fig. 1.

COMMENT AND CONCLUSIONS

This method eliminates pouring and flaming. We feel that it offers better aseptic technique and greater safety where explosive anesthetics are being used. It has the additional advantages of keeping the blood mixed and of readily showing the rate of flow.

PRIMARY TUBERCULOUS PERIPHERAL VASCULAR DISEASE

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IN THE classification of diseases producing chronic peripheral vascular deficiency, tuberculosis is given a place. This place, however, is but little substantiated in the literature by specific examples of primary tuberculosis producing obstruction in peripheral vessels.

Secondary involvement of large blood vessels by extension of tuberculosis has often been reported, a common sequela being aneurysm formation. Baumgarten and Cantor¹ collected twenty cases caused by proved tuberculous arteritis. Of these twenty cases, four were considered not to be the result of direct extension but rather of hematogenous infection of the vasa vasorum. The case reported by Baumgarten and Cantor was that of an aneurysm of the femoral artery, so destructive that amputation of the leg was necessary. No primary tuberculous focus was found and the patient was alive and well three years later. The pathologist's report showed that all three coats of the artery had many tubercles. Without evidence of tuberculosis elsewhere, this can be considered as a primary tuberculous arteritis of a large vessel.

Tuberculous phlebitis secondary to tuberculosis elsewhere in the body is reported not uncommonly, and when seen in advanced cases of pulmonary tuberculosis has long been considered a poor prognostic sign. Whether the phlebitis results from the cachexia and peripheral venous stasis associated with the disease or whether caused by specific tuberculous lesions of the vessels is not entirely clear. Dodwell and Lond² in 1893 reported twenty instances of venous thrombosis in patients with advanced pulmonary tuberculosis, but autopsy studies showed no specific lesions in the vessels involved. Halbron and Paraf³ cultured the blood clots from the thrombosed peripheral vessels of another series of thirteen such patients and in only four instances were the cultures positive for tubercle bacilli. However, guinea pig inoculation with blood clot from four other similar cases brought positive results in each case. These observations might well be explained by a terminal bacilleemia, especially in view of the fact that microscopic examination of three of the veins failed to show any changes typical of tuberculosis. Ferrari and Fosatti,⁴ in a similar study, were unable to demonstrate a specific etiology for the peripheral thrombosis seen in advanced pulmonary tuberculosis.

Also associated with pulmonary tuberculosis is a type of phlebitis characterized by involvement in rapid succession of many superficial

veins, followed by quick local recovery. Bernard, Solomon, and Coste⁵ found this condition in individuals with advanced pulmonary tuberculosis, but Hirtz⁶ reported and Lafforgue⁷ described the condition in persons without discernible tuberculosis at the time of the first examination. Further examinations have showed that a large number of these latter patients developed miliary tuberculosis. Lafforgue⁷ terms the condition "*la phlébite précoce des tuberculeux pulmonaires*" and believes in the specific etiology of the lesions. Their bacteriologic and pathologic proof, however, are lacking, as all cultures and microscopic studies failed to show either tubercle bacilli or their typical lesions.

Altschüler⁸ describes two patients with peripheral thrombophlebitis of a recurring nature which on biopsy showed intimal tuberculosis of the veins. Neither had evidence of tuberculosis elsewhere in the body.

The case we wish to report, that of a patient losing fingers and toes as a result of a chronic peripheral vascular deficiency due to localized tuberculosis, is decidedly uncommon. It is the only instance of this condition among the large number of persons treated for peripheral vascular disease at the University Hospital in the past ten years.

CASE REPORT.—H. S., No. 330664, a 35-year-old white male, was first seen at the University Hospital, February, 1934, with a chief complaint of cold, dusky extremities and intermittent sores and infections of fingers and toes.

Twenty years before the patient had "frozen" his hands and feet. Ten months before entry the third finger of the left hand was injured, did not heal, so was partially amputated. Four months before entry a black blister developed on the right great toe and continued to "eat in," so the toe was amputated. Numerous other sores healed with the loss of some tissue. There had been cramping pain in the calves upon walking and a few painful nodules had appeared in the skin of the legs. There was no family history or known contact of tuberculosis. Health, other than the present illness, had been good.

Physical examination on entry showed a well-developed and well-nourished white male. Lung fields were clear; heart, normal; blood pressure, 112/70; abdomen, normal. There had been an amputation of the left third finger through the middle phalanx; the stump showed active ulceration and inflammation. The left fourth finger was deformed from partial loss of the distal phalanx. The circulation in the forefeet appeared to be poor, the skin was paler than normal, the veins were poorly filled. There was moderate rubor of the feet on dependency and pallor on elevation. The right great toe had been amputated and the left great toe was cyanotic and tender. The distal pulses were as follows:

	RIGHT	LEFT
Radial artery	Good	Good
Ulnar artery	Not felt	Not felt
Posterior tibial artery	Very weak	Not felt
Dorsalis pedis artery	Fair	Very weak

The skin temperature environmental response showed a moderate degree of organic vascular occlusion. The urine and Kahn tests were normal. A leucocytosis of 10,000 to 14,000 per cubic millimeter was present on several occasions. A roentgenogram showed the chest to be normal.

A diagnosis of organic peripheral vascular deficiency was made. The disease was not considered to be typical of thromboangiitis obliterans, although suggestive of it. A sinus tract on the third right finger was curetted and a biopsy was made from an

area of recent superficial phlebitis in the left calf, which was reported* as follows: "Obliterating tuberculous phlebitis. The media and adventitia show but slight involvement as compared to the intima in which the process is granulomatous, avascular, epithelioid and caseating. Final occlusion has been accomplished by a thrombus which is now showing early organization." The sinus curettings showed "fragments of necrotic bone, granulation tissue, and masses of caseous necrotic material. No tubercles in this tissue, but might well come from an area of tuberculous osteomyelitis." A high and low power photograph of a typical microscopic section from the calf vein is shown in Fig. 1. The finger healed in two weeks and the patient was discharged.



Fig. 1.—Obliterating tuberculous phlebitis of right calf vein.

The patient was well for eight months until the cold weather of November, 1934, when the left great toe became swollen and was lanced several times. In February, 1935, the left fourth finger became swollen and was incised, and during these winter months the patient had great trouble in keeping his hands and feet warm. In March, 1935, the patient was readmitted to the hospital with pus draining from the left fourth finger and from the amputation stump of the left great toe. Wide drainage

was obtained and the conservative measures employed in the treatment of a peripheral vascular deficiency were again instituted. The response was extremely slow. A long area of phlebitis developed on the dorsum of the left forearm in September, 1935, was biopsied, and reported* as "a vein somewhat larger than the one examined from the leg, and showing a productive granulomatous intimitis with final obliteration from thrombosis. In the granulomatous tissue, partially filling the lumen, are numerous nodular formations of epithelioid cells and giant cells with slight central

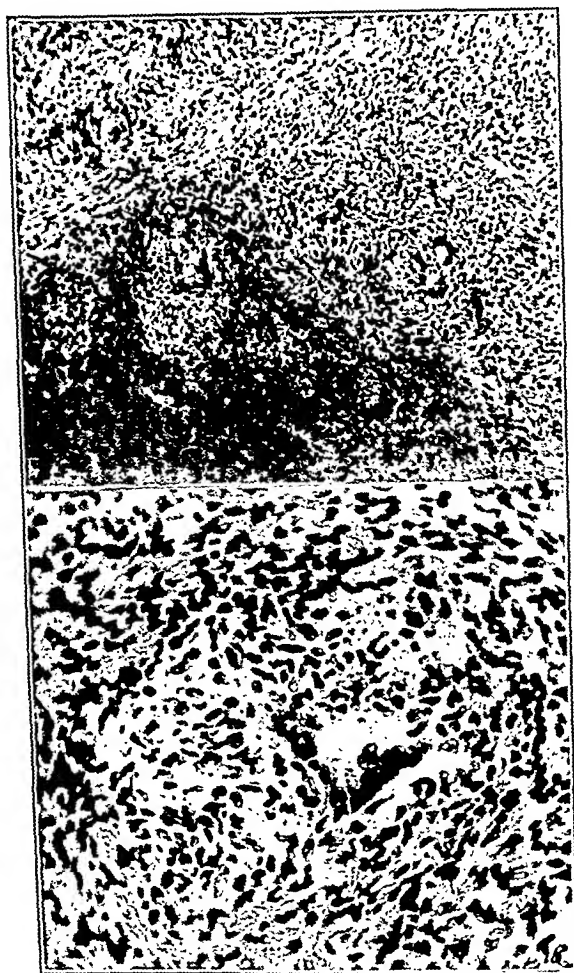


Fig. 2.—Obliterating tuberculous endophlebitis and phlebitis of left forearm vein.

caseous necrosis. Histologically these resemble tubercles in every respect. Obliterating tuberculous endophlebitis and phlebitis." A high and low power photograph representative of the tissue removed is shown in Fig. 2. The left fourth finger was re-amputated twice and a midpalmar space infection was drained. By January, 1936, the hand had healed and only a slight amount of pus drained from the sinus in the left great toe. The patient's general condition was excellent and chest roentgenograms again showed no evidence of tuberculosis.

*All pathologic diagnoses were made by the Department of Pathology, and the authors wish to express their appreciation of the aid given by its chairman, Dr. C. V. Weller.

In October, 1936, the patient was again seen with a complaint of difficulty in keeping his hands and feet warm. At this time no pulsation could be felt along the radial, ulnar, dorsalis pedis, or posterior tibial arteries. The tip of the left index finger showed a small, very tender ulcer, and tissue removed from the edge of the ulcer was reported as "fibrino-purulent exudate, caseation necrosis but no definite tubercle formation, purulent osteomyelitis." With out-patient dressings, the ulcer was healed in three months' time.

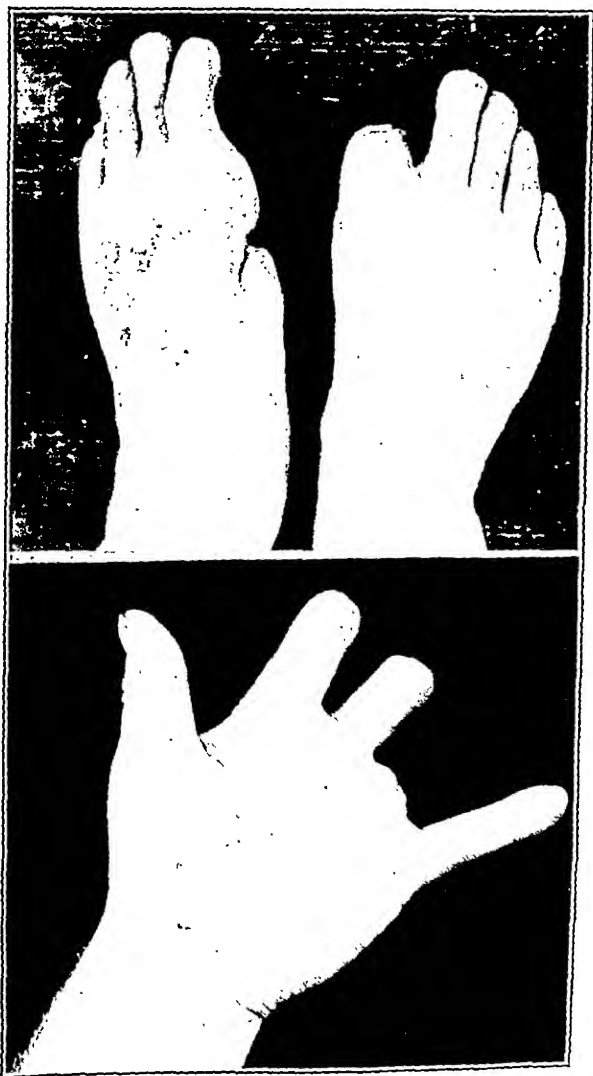


Fig. 3.—Deformities of left hand and the feet four years after original admission.

The last examination of this patient was in May, 1938, four years after the original admission. Fig. 3 shows the deformities of the left hand and the feet at that time. The patient's general health was excellent, but he had been unable to work for the previous six months because of recurrent ulcerations of his feet. Again there was no evidence of systemic tuberculosis, and x-rays of the feet showed no

active bone lesions. Various measures stimulating the peripheral circulation were instituted, but progress towards the healing of the ulcers was slow.

COMMENT

Although guinea pig inoculations and cultures were not done and special stains for tubercle bacilli were negative, we believe that the pathologic picture warrants a diagnosis of primary peripheral vascular tuberculosis. The clinical aspects of the patient were those of a chronic vascular deficiency and the course of the disease has been somewhat similar to that of thromboangiitis obliterans. With treatment, areas of involvement have healed and new lesions have developed later.

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A SIMPLE METHOD OF APPLYING HEAD DRESSINGS

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MOST injuries to the scalp are covered with a bulky head dressing which is held in place by roller bandages. These are conspicuous and often uncomfortable. Many times the patient is not overly anxious to have his head wound advertised by a large dressing. Collodion dressings are often used for this type of dressing but are far from ideal. These dressings are annoying to apply and difficult to remove. A scalp dressing has been described¹ which is held in place by tying locks of hair together with silk. In some cases it is efficient, but in short-haired individuals it is not possible.

A simple head dressing is here presented which is easily applied and removed. A gauze pad is applied over the wound and strands of hair are pulled over each edge of the pad. A small piece of adhesive tape, which is just large enough to cover the ends of hair, is applied. (Fig. 1.)



Fig. 1.

Due to the oil in most hair, it is advisable to moisten the adhesive tape with ether before its application. The bandage is painlessly and rapidly removed by dampening the adhesive tape with ether and gently pulling it away from the locks of hair. It can be seen from the illustration that dressings of varying size may be applied which are light, comfortable, and inconspicuous and which may be changed as often as needed.

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Editorial

A Present-Day Appreciation of Beaumont's Experiments on Alexis St. Martin

BEHIND every experiment is a man. The character and the mental attitude of the man bear on the character of his observations and their interpretation. Hence, it is appropriate, first, to depict the character of the man, Beaumont. This can best be done by using his own statements.

"I had opportunities for the examination of the interior of the stomach . . ." "I have availed myself of the opportunity afforded . . ." "I submit a body of facts which cannot be invalidated." "The reader will perceive some slight seeming discrepancies . . . ; but he will recollect that the human machine" is subject to some variation in the same and different individuals . . . "I am fully aware of the importance of the subject . . . ; I am therefore willing to risk the censure or neglect of critics, if I may be permitted . . . to be the means, either directly or indirectly, of subserving the cause of truth, . . ." "I make no claim to originality in my opinions, . . ." "I consider myself but a humble inquirer after truth—a simple experimenter." "My opinions may be doubted, denied or approved, . . . ; but their worth will be best determined by the foundation on which they rest—the incontrovertible facts." "Truth, like beauty, when 'unadorned, is adorned the most,' and, in prosecuting these experiments and inquiries, I believe I have been guided by its light." More inspirational statements cannot be found in the writings of any other scientist.

It is no wonder that a man imbued with such a spirit made many observations, all of which have been confirmed. Certain of his interpretations were in error, but it must be remembered that Beaumont worked with only a "gum-elastic tube," a magnifying glass, a scale, a thermometer, an incubator consisting either of a basin of water on a sand bath or an armpit, a muslin filter, nutgall, and his five senses. Moreover, in his day the science of physiology was barely an embryo, particularly in the field of digestion. Thus, certain of his interpretations were erroneous, not because of an error in observation but because the observations have since assumed a new meaning which either was not or could not have been recognized by Beaumont. Yet, even today, one marvels at the high degree of accuracy of his fifty-one inferences, or conclusions, listed on page 200 of *Life and Letters of Dr. William Beaumont* by Dr. Jesse A. Myer.

In Inference 24 Beaumont states that gastric juice "contains free muriatic acid and some other active chemical principles." In another place he states: "I had been long convinced of the existence of free muriatic acid in the gastric fluids. Indeed, it is quite obvious to the sense of taste . . ." Yet, in some of his classic experiments on artificial digestion he added muriatic acid and acetic acid to water. In Experiment 10⁴ he used "four drachms of a mixture of dilute muriatic and acetic acids, reduced with water to the flavor of the gastric fluid, as nearly as practicable—three parts of the muriatic to one part of the acetic . . ." Does this mean that Beaumont was able to detect by taste a difference between the free and total acidity of gastric fluid, or was he misled by the odor of the gastric contents of the bibulous St. Martin?

Beaumont's scientific method of conducting experiments proved that something is present in gastric juice other than acid which facilitates digestion. He showed that gastric juice digested meat at body temperature much better than at room temperature and that gastric juice was a better digestant than dilute muriatic acid. If he had boiled gastric juice, he would certainly have discovered pepsin, and perhaps rennin. However, his experiments on artificial digestion were far in advance of his day, and it appears that Beaumont's suggestion led to the discovery of pepsin in 1836 by Schwann, who refers to Beaumont.

The following passages briefly outline Beaumont's observations and opinions, which render him partly responsible for promulgating three erroneous views. There is nothing wrong with the observations; in fact, they are classic; only their interpretation is misleading. In Inference 25 Beaumont states that gastric juice "is never found free in the gastric cavity; but is always excited to discharge itself by the introduction of food, or other irritants." In Inference 14 he states that "hunger is the effect of distension of the vessels that secrete the gastric juice." In his discussion (p. 59)* he states: "On applying aliment to the internal coat of the stomach . . . the orifices, undoubtedly, of the gastric vessels, immediately throw out a quantity of the fluid, which mixes with the food . . . when the stomach is destitute of food or some other irritating substance, no such secretion can be found in it. And it is more than probable . . . that a large quantity of this fluid must be contained in appropriate vessels, during a fast, ready to obey the call of aliment. I would not be understood to say that the whole quantity necessary for an ordinary meal is eliminated from the blood, previous to the commencement of alimentation; but that enough is contained in the gastric vessels to produce the sensation of pain and hunger." He points out that hunger distress is almost immediately relieved when a little food causes the juice in the gastric vessels to be extruded. Regarding the secretion of the fasting stomach he says: "The gastric juice never appears to be ac-

*Beaumont, William: *Experiments and Observations on the Gastric Juice and the Physiology of Digestion*, Plattsburgh, 1833.

cumulated in the cavity of the stomach while fasting; and is seldom, if ever, discharged from its secreting vessels, except when excited by the natural stimulus of aliment, mechanical irritation of tubes, or other excitants" (p. 105). Yet, the protocols of many of his experiments show that he obtained from one-half to two and one-half ounces of acid fluid from the fasting stomach. His interpretation (p. 137) was: "I infer that the fluid, in these experiments, was incidented to discharge itself by the irritation of the tube used in extracting it." In Experiment 63 (p. 207) is found the following interesting observation: "There was no free fluid in the gastric cavity, until after the elastic tube was introduced, when it began slowly to distill from the end of the tube, drop by drop, perfectly transparent, and distinctly acid. I obtained about one drachm of this kind, and then gave him a mouthful of bread to eat. No sooner had he swallowed it, than the fluid commenced flowing more freely from the tube, and I obtained two drachms, less pure, however, with saliva and mucus mixed with it, and slightly tinged with yellow bile. The surface of the protruded portion of the villous coat at this time became covered with a limpid fluid, uniformly spread over its whole surface, distilling from myriads of very fine papillary points, and trickling down the sides." Later he "introduced the tube and obtained about two drachms more of very pure gastric juices." It is clear that Beaumont believed that hunger distress was due to distention of the gastric glands with stored gastric juice, that the secretion he found in the empty stomach was due to the mechanically excited extrusion of the stored secretion, that contact of food with the gastric mucosa caused secretion by the chemical action of the food on the mucosa, and that the sudden response of the gastric glands to swallowed food was due to the chemical stimulation of the food in contact with the gastric mucosa.

In retrospect, if Beaumont had emptied the stomach completely and then had in some instances collected for a half-hour the continuous secretion of the stomach and then had manipulated the mucosa with his thermometer, he would have found no sudden discharge on mechanical stimulation of secretion. If he had distended the stomach, he probably would have found that mechanical distention, the only significant and adequate mechanical stimulus, would stimulate. Having found that gastric juice was not stored in the gastric glands, he would not have proposed his theory of hunger. Also, if he had told St. Martin to take the bread in his mouth and chew but not swallow it, he would have discovered the psychic secretion of gastric juice, which he actually observed without realizing it. Further, if Beaumont had associated the pain in the pit of the stomach, which he produced when he caused St. Martin's stomach to contract by irritation with the thermometer bulb, with the pain of hunger, he would probably have recognized that hunger pain was due to gastric contractions. Beaumont's idea that the gastric juice secreted in fasting was stored in the gastric glands caused him to mis-

interpret hunger distress, to believe that the empty stomach frequently does not secrete acid, and perhaps to miss the discovery of psychic secretion or the effect of nerves on secretion. In his day, of course, the concept of secretory nerves had not arrived. The existence of secretory nerves was proved by Ludwig in 1851, and the concept was prevalent when Bidder and Schmidt in 1852 first recorded the observation of the psychic secretion of gastric juice.

According to the implications of his own statements, Beaumont derived his turgescence theory of the hunger sensation from his belief that the mucosa of the stomach is analogous to erectile tissue. He refers to "the erectile tissue of the villous coat of the stomach." In reference to the hunger sensation he says: "The sensation varies according to the different degrees or states of distension, from the simplest desire to the most painful sense of hunger." He writes, further, of "the pain from acute inflammation by distension of blood vessels," of "the effect of vascular distension of blood vessels," of "the quiescence and relief from the unpleasant sensations which are experienced as soon as the vessels are emptied." He answers the possible criticism that the accumulation of gastric juice in the vessels might rupture by pointing out that "this apparatus is constituted like many other organs—and permits absorption of its secretions, so they do not rupture." "The male semen is constantly being secreted, and deposited in its proper seminal vessels, ready to be ejected," yet it is "taken up—by absorbing vessels, as the gastric juice is." He was apparently much impressed by the phenomena of the blushing and blanching of the gastric mucosa, and hence compared the phenomena with those vascular changes and sensations manifested by erectile and inflamed tissue. He overlooked the intermittent and recurrent character of hunger pains, which is experienced by most persons if they fast long enough.

Beaumont unequivocally distinguished between mechanical and chemical stimulation of the gastric glands. He discovered that certain foods act as chemical excitants of the gastric glands, and he demonstrated unequivocally that oily food is difficult to digest. He showed, but was not the first to do so, that bile aids the emulsification of fat. He knew that bile was alkaline, but suspected that pancreatic juice (p. 164) was slightly acid. He believed that saliva has no digestive action, that it only lubricates. This view was probably based on the fact that he added saliva to gastric juice, the acidity of which inactivated the ptyalin, and, being on the frontier, he was not acquainted with the discovery of Leuchs (1831) that saliva liquefies and decomposes cooked starches.

Most of Beaumont's experiments on the rate of digestion are classics. However, he could not distinguish between what we now call enzymatic digestion and chymification. He proved that vegetables, especially large pieces of raw or cooked vegetables, were more difficult of digestion, or rather chymification, than meats and farinaceous foods. Because he

did not know of the digestive action of saliva on cooked starch he surmised, on the basis of filtration and sedimentation, that gastric juice dissolved starches. If chymification is substituted for digestion in Beaumont's statements regarding the changes the minutely divided vegetables underwent in his experiments, little objection can be made to his interpretations.

The movements of the pyloric portion of the stomach were remarkably well described by Beaumont when it is considered that he had to infer what was happening by feeling through the aid of his thermometer. In regard to the movements of the fundus of the stomach, he described a rotary motion of the contents, which he said was not "very exact," the contents being "intimately mixed and circulating promiscuously." His emphasis on the rotary motion (p. 110) was probably due to the pathologic fixation of St. Martin's stomach. Yet, he observed that the movements of the fundus increase as digestion progresses; and, in his conclusions, he states correctly that "the movements of the stomach produce a constant churning of its contents" and "that these motions are in two directions—transversely and longitudinally."

In regard to the effect of emotions, overindulgence in food and drink, and febrile conditions on the appearance of the stomach, every modern gastroscopist would profit by reading Beaumont's descriptions of the gastric mucosa as affected by these conditions. In this connection a statement made by Beaumont should be quoted (p. 240) for emphasis: "It is interesting to observe to what extent the stomach, perhaps the most important organ of the animal system, may become diseased, without manifesting any external symptoms of such disease, or any evident signs of functional aberration."

One truly does not know gastric physiology and pathology as one should until Beaumont has been read critically and *in toto*. It should be emphasized that many important observations are not mentioned in his list of fifty-one inferences. For example, among his observations, he records that hot, humid weather depresses gastric secretion, that the temperature of the pyloric antrum is higher than that of the fundus, that too much cooking hardens the food so that it is not easily digested, that too much condiment irritates the gastric mucosa, that the appearance of the tongue is an indicator of the healthy or unhealthy state of the stomach, that the mechanical action of a muslin bag containing food and prevented from passing the pylorus by means of a string irritates the gastric mucosa, that the cardiac sphincter visibly opens and closes after swallowing, and that thirst "is felt in the mouth and fauces" and "the proximate cause may exist in an irritation, a kind of sub-inflammation of the mucous membranes of the mouth and fauces, the effect of the viscid state of the blood, and consequently impervious state of the secretory vessels of these membranes." These and many other impor-

interpret hunger distress, to believe that the empty stomach frequently does not secrete acid, and perhaps to miss the discovery of psychic secretion or the effect of nerves on secretion. In his day, of course, the concept of secretory nerves had not arrived. The existence of secretory nerves was proved by Ludwig in 1851, and the concept was prevalent when Bidder and Schmidt in 1852 first recorded the observation of the psychic secretion of gastric juice.

According to the implications of his own statements, Beaumont derived his turgescence theory of the hunger sensation from his belief that the mucosa of the stomach is analogous to erectile tissue. He refers to "the erectile tissue of the villous coat of the stomach." In reference to the hunger sensation he says: "The sensation varies according to the different degrees or states of distension, from the simplest desire to the most painful sense of hunger." He writes, further, of "the pain from acute inflammation by distension of blood vessels," of "the effect of vascular distension of blood vessels," of "the quiescence and relief from the unpleasant sensations which are experienced as soon as the vessels are emptied." He answers the possible criticism that the accumulation of gastric juice in the vessels might rupture by pointing out that "this apparatus is constituted like many other organs—and permits absorption of its secretions, so they do not rupture." "The male semen is constantly being secreted, and deposited in its proper seminal vessels, ready to be ejected," yet it is "taken up—by absorbing vessels, as the gastric juice is." He was apparently much impressed by the phenomena of the blushing and blanching of the gastric mucosa, and hence compared the phenomena with those vascular changes and sensations manifested by erectile and inflamed tissue. He overlooked the intermittent and recurrent character of hunger pains, which is experienced by most persons if they fast long enough.

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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

RECENT ADVANCES IN SURGERY OF THE ESOPHAGUS

CLARENCE E. BIRD, M.D., PROVIDENCE, R. I.

CONGENITAL DEFECTS

Atresia With Tracheoesophageal Fistula.—Mixer (1936) reported that during a period of ten years twenty-three cases of atresia of the esophagus with tracheoesophageal fistula were seen at the Children's Hospital in Boston. Although it is an uncommon anomaly, any surgeon may be confronted by such a case. The tract usually exists between the lower segment of the esophagus and the trachea, rarely between the lower segment and a main bronchus. A. D. Smith (1937) performed an autopsy on an infant with a still less common communication between the upper esophageal pouch and the trachea.

The uniform symptoms, which are regurgitation of milk and mucus, with attacks of choking, cyanosis, and coughing, occur when the infant is first fed. A plain roentgenogram of the abdomen shows the stomach and sometimes the intestines filled with air (van Gilse, 1924; Vogt, 1929; Reid, 1932; Solis-Cohen and Levine, 1936), thus proving the presence of a tracheoesophageal fistula (which occurs in about 75 per cent of the cases of atresia), as distinguished from the far less common complete or incomplete atresia of the esophagus without a fistula (25 per cent). Nothing further is necessary to establish the diagnosis, and injection of barium or lipiodol (Brockington and Lightwood, 1933) in order to demonstrate the blind pouch or the fistula may prove harmful (Scott, 1939,* and others). It is important to search for associated anomalies, which are present in about 60 per cent of the cases, excluding open foramen ovale and ductus arteriosus. The anomalies are often compatible with life. In about 30 per cent the defect is anal atresia (Plass, 1919).

As Blair (1936) pointed out: "If you are going to do anything radical in an infant, do it at the earliest possible moment and you will be most likely to succeed." This is especially true in an infant with tracheoesophageal fistula, because prevention of the repeated aspiration of septic material into the lungs is fundamental if a cure is to be hoped for.

*In one of Scott's infants whose stomach was transected and who died five weeks later, autopsy showed multiple lung abscesses surrounding deposits of barium which had been injected for diagnostic purposes before Scott saw the patient.
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tant facts may be gleaned only by reading all of the 279 pages of Beaumont's *Experiments and Observations on the Gastric Juice and the Physiology of Digestion*.

Beaumont's observations not only provided many important new facts, but they also suggested a new method of approach to the study of gastric physiology and directly and indirectly stimulated a tremendous amount of investigation.

At the meeting of the International Congress of Physiologists in Boston in 1929, each guest was presented with a medallion bearing the likeness of Beaumont and a facsimile of the original edition of his book. William Beaumont, the frontier physician and physiologist, on this occasion, was figuratively canonized as the patron saint of American physiology. Modern American physiologists can pay no greater honor and respect to any man.

—Andrew Conway Ivy, Ph.D., M.D.
Chicago, Ill.

tions of this kind, he added a cervical esophagostomy either at the primary operation or within a few days. All patients so treated died.

In the same year, Bohrer, in a discussion of Leven's paper, described a similar procedure, but by an anterior extrapleural approach. This was made by resecting the left fourth costal cartilage and adjacent section of rib, displacing the pleura and lung, and exposing the fistula. The fistula was divided and closed and the stump of the elastic esophagus was easily brought out through the wound for feeding. Bohrer had found the approach satisfactory. The child was in poor condition before operation and died shortly, but he thinks the procedure feasible.

Leven (1936) adopted an entirely new principle, which is promising. The two infants he reports upon lived ninety-eight and fifty-three days, respectively. In each case, at the earliest possible moment consistent with adequate administration of fluids, he opened the abdomen under local anesthesia in the upper midline and gently lifted up the stomach and angulated it out of the wound. A tube was introduced toward the pylorus for feeding. The lungs and lower esophagus drained themselves continually into the isolated upper segment of the stomach, which was kept dry by aspiration. Leven prevented overflow into the lungs from the blind cervical esophageal sac by repeated aspiration of the mouth and pharynx with a bulb syringe. He advised against either a transnasal or transoral intubing catheter because of the great danger of ascending infection through the Eustachian tubes, which in infants lie more horizontally than in adults. This point was corroborated by Wangenstein in discussion.

Gamble (1938) used the same principle, but severed the stomach (as had Scott), used the exteriorized upper stump to drain the lower esophagus, closed the lower stump, and added a gastrostomy for feeding. This infant died on the fifteenth postoperative day, not of pneumonia, but from hemorrhage and generalized peritonitis, the result of perforation of an ulcer on the anterior wall of the lower segment of the stomach.

Scott (1934) operated upon an infant on the second day after birth; transection of the stomach and gastrostomy were carried out as one procedure. The child lived four and one-half months; at autopsy there was purulent bronchitis with slight interstitial pneumonia. Scott believes that acid secreted by the upper gastric segment may irritate the tracheal mucosa and proposes leaving a minimum gastric stump, the mucosa of which should be destroyed so far as possible.

Seiffert (1934) suggested an ingenious endoscopic method, but had had no opportunity to carry it out. He proposed to insert, through a bronchoscope, a catheter to which a small rubber balloon had been attached. This would be passed through the fistula into the esophagus, inflated, and pulled back against the fistula. He then envisaged the insertion of a needle through the upper blind sac, keeping close to the trachea, until the balloon was punctured. He could then incise or electro-

Evidence has accumulated to show that *gastrostomy or jejunostomy*, with or without ligation of the lower esophagus, is futile (e.g., Smith, 1923; Simpson, 1929). Aspiration bronchopneumonia occurs uniformly.

Before any operation is attempted, it is important to provide adequate amounts of fluid and dextrose parenterally. The child must be kept warm. At operation, manipulation must be gentle. Anesthesia should be local. If an inhalation anesthetic is attempted, especially under positive pressure, the stomach will inflate with gas forced through the fistula.

The essential surgical problem is to prevent drowning of the lung either through the fistula from below or by overflow into the trachea from the blind esophageal pouch above. The earliest rational attempt to cure these patients was made by Richter (1913), who in two cases closed the fistula by right transpleural thoracotomy followed by gastrostomy. One infant died of "shock," the other of aspiration pneumonia which had begun before operation. Although several authors refer to Richter's work with admiration, no further progress appears to have been made until 1934, when Iglauer proposed, but did not carry out, a program of cure based partly on the diagnostic work of Tucker and Pendergrass (1933). In a typical case, the latter authors: (1) aspirated the upper blind pouch through a 3.5 mm. esophagoscope, introduced a small amount of bismuth mixture, took roentgenograms, then aspirated the bismuth; (2) introduced a 3.5 mm. bronchoscope, located the fistula, and passed a ureteral catheter through the opening into the lower esophagus and stomach. Gastrostomy and intra-abdominal ligation of the lower esophagus followed, but, as always, the child died of aspiration pneumonia.

Iglauer's plan was as follows: (1) cervical esophagostomy in one or two stages, depending on whether or not the blind sac could be brought to the skin; (2) the placing of a specially prepared ureteral catheter through the fistula into the lower esophagus; (3) right posterior, transpleural thoracotomy, closure of the fistula, exteriorization of the stump of the lower esophagus for tube feeding into the stomach; (4) tight closure of the uncontaminated thorax with lungs expanded under positive pressure. The ureteral catheter was to be prepared by: (1) sealing the tip with paraffin to prevent insufflation of the stomach, (2) applying a rubber collar to occlude the fistula, and (3) perforating the catheter above the collar to allow insufflation of ether vapor under positive pressure. The fistula was to be ligated and severed through the catheter, thus allowing the catheter to be drawn up only slightly in order to sew over the opening, then to continue the insufflation. This theoretically promising program seems never to have been carried out.

In 1936, Gage and Ochsner reported two failures after ligation of the lower esophagus and gastrostomy. In discussion, Mixer stated that in 1929 he had severed the fistula by a posterior approach and then brought the esophagus out at the back for feeding. After several futile opera-

of wheat. The other members of the family, who had eaten ordinary food, had carious and infected teeth. The point was made that in this case mastication of solid food had not been essential for the normal rugged development of the jaws and teeth. The general nutrition was excellent.

The Congenitally Short Esophagus.—Since Richard Bright's description (1836) of the post-mortem findings in a case of congenitally short esophagus and Bailey's interpretation of the anomaly on an embryological basis (1919), a number of reports of this interesting condition have appeared. Often the finding has been incidental, in cadavers (Blasingame, 1936), or at autopsy, or when roentgenologic studies have been made for unrelated conditions; sometimes in elderly individuals who have never had dysphagia, as in one of my cases. Some patients have had symptoms directly related to obstruction in the esophagus. A man, aged 63 years (Weaver and Moersch, 1938), had been troubled for twenty or thirty years by epigastric burning, gaseous eructations, and heartburn, relieved by taking soda. During eighteen months there had been increasing dysphagia and loss of 33 pounds in weight. An x-ray diagnosis of carcinoma of the esophagus was made, but a large mass containing persimmon skins was removed through an esophagoscope. The persimmon ball had formed at a point of narrowing and superficial ulceration where the congenitally short esophagus joined the intrathoracic portion of the stomach. The patient recalled having eaten the persimmons shortly before the onset of symptoms of obstruction. Ross (1934) ascribed the distress in his patient, at least in part, to distention of the portion of the stomach which lay above the diaphragm. Ulceration and bleeding have occurred in the lowermost part of the esophagus or in the intrathoracic portion of the stomach.

Clerf and Manges (1934) state that previous to the illuminating report of Findlay and Kelly (1931), congenital short esophagus was confused with acquired stricture, simple ulceration with cicatricial narrowing, or with narrowing secondary to herniation of the stomach through the diaphragmatic hiatus. The case reported by Eichelman (1923) as congenital stenosis of the esophagus in all probability was of this nature. Most of the cases are accompanied by narrowing of the esophagus at or just above the high esophagogastric junction. This is true whether or not there are symptoms referable to the anomaly. Non-ulcerated cases are satisfactorily managed by thorough mastication of food and occasional esophagoscopy dilatations. Ulcerative cases with pain are difficult to treat, although a gastric diet with alkalis and bismuth subnitrate by mouth, or the application of 10 per cent silver nitrate to the ulcer, or careful esophagoscopy dilatation may help. Gastrostomy and prolonged rest of the esophagus may be necessary. Interesting cases are recorded by Kelly (1930), Monkhouse and Montgomery (1933), and Dunhill (1934). The narrowed channel and the

coagulate along the needle until he entered the esophagus. A catheter could now be passed through the upper blind sac down into the stomach, and the tracheoesophageal fistula could be closed by application of silver nitrate.

Obstruction Without Tracheoesophageal Fistula.—Complete atresia of the esophagus without tracheoesophageal fistula is an uncommon anomaly (Vinson, 1925), but it should be treated successfully by gastrostomy and cervical esophagostomy if the infants are operated upon early enough. Nevertheless, in the cases reported, the infants have died (Hirsch, 1921; Reynolds and Morrison, 1921; Vinson, 1923; Unger and Poppel, 1938). If recovery should occur, some variety of antethoracic esophagoplasty might later establish the normal swallowing function.

Membranous diaphragms (Mosher, 1911; Abel, 1928; Eckerström, 1932), webs and folds (Sunde, 1937), and the tubular atresias through which there is at least a narrow channel are managed successfully by rupturing the webs or by dilating through an esophagoscope (e.g., Mosher, 1917; Morse, 1920; Vinson, 1923; Beatty, 1928; Harpprecht, 1934). The chief problem of the endoscopist is to get a catheter or string through the stricture. Occasionally it is necessary to make a gastrostomy for retrograde bougienage or to find a minute lumen which may not be visible from above. The use of a ureteral catheter to pass a narrow congenital stricture from below is described by Fitzgibbon (1926) and Simpson (1933). Dilatations by any one of several methods, repeated over a period of months or years, may then lead to normal or near normal passage of food and saliva. Some authors believe electrolysis improves the results of dilatation in some cases (Guisez, 1920; Abel, 1928; Demel, 1933). Simpson, in a 2-day-old infant, treated a case of stenosis of the cardia by gastrostomy followed by retrograde dilatations with an improvised Plummer bag.

Strauss and Hess (1925) were more radical in the management of three patients under 3 years of age who had partial congenital stenosis of the esophagus immediately above the cardiac orifice. They opened the stomach, attached forceps to a catheter which had been passed down through the mouth, pulled the forceps into the stricture, then cut down on them to the mucosa, in the manner of the Ramstedt operation for congenital pyloric stenosis. Two of the babies lived. They believed the operation to be safer and more satisfactory than dilatation by endoscopic means for congenital strictures in this lowermost portion of the esophagus. In a girl, aged 17 years, with congenital stenosis, Petersen (1921) obtained an excellent functional result by constructing an antethoracic esophagus of the Lexer (1911) type. This was an esophago-dermatojejunogastrostomy.

Austin and Vinson (1933) reported the case of a farm hand, aged 23 years, afflicted with congenital stenosis, whose jaws and teeth had developed normally on a diet consisting largely of milk, cocoa, and cream

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Carlson, Boyd, and Pearcey (1922) confirmed and extended Openchowski's observations on the reflex control of the cardia and lower esophagus, thereby laying the groundwork for the possibility that clinical "cardio-spasm" in some cases may be caused reflexly by distant lesions, such as disease of the gall bladder.

Bohrer (1934), in searching for the explanation of the immediate relief, following dilatation, of symptoms in a female infant, 19 months old, asked if there may not be an unrecognized fissure or ulcer in these cases. It is interesting to recall that Mikulicz (1904) compared his method of dilatation of the cardia (with a clamp or the fingers) to dilatation of the rectum for fissure-in-ano. However, in view of the fact that there is no characteristic pain in most cases, and, inasmuch as Rake and others have demonstrated the degenerative changes in Auerbach's plexus, the presence of a fissure or ulcer as the cause of a retention spasm does not seem very likely.*

*Spasm arising in the portion of the esophagus between the cricopharyngeus and the cardia without any intrinsic esophageal lesion is described as simple nonphincteric spasm of the esophagus by McGibbon and Mather (1937). The diagnosis is a dangerous one without the most careful investigation, as spasm of the esophagus is common in association with graver lesions. Simple nonphincteric spasm may be localized or diffuse; it may be transient, intermittent, or persistent in character. The radiological appearances are typical, and as a rule esophagoscopy is negative. It is a neurogenic manifestation and may be followed by achalasia. As a rule, this type of spasm is secondary to disease or an altered state of other organs, and, if it does not resolve spontaneously, satisfactory relief can only be obtained by treating the primary lesion. The similarity of the pain in these cases to that of angina pectoris is mentioned by Moersch and Camp (1934). D. E. Jackson and H. L. Jackson (1936) believe that alterations in esophageal and gastric tone (distention and shortening) are the cause of angina pectoris. Expressed in another way, these authors state that in their opinion "angina pectoris is due to acute, spasmodic, incoordinated contractions of the esophagus and stomach." They explain sudden death in this disease on the basis of reflex inhibition of the heart, due to gas or food entrapped under pressure in the esophagus. They note that the acute symptoms often may be relieved by passing a stomach tube. As might be expected, the pain of diaphragmatic hernia is often similar. An interesting study of direct splanchnic and referred pain from the esophagus is to be found in the publication of Stürup (1937). Moore (1930) and Pepper (1937) noted that pain originating from disorders of the esophagus is often mistaken for pain of cardiac origin. Pollard and Bloomfield (1931) advanced evidence that the symptoms of patients with epigastric distress associated with peptic ulcer of the stomach or duodenum may be due to reflex spasm of the esophagus. In some patients, a distended balloon within the esophagus reproduced "heartburn" even though no acid was present, agreeing with the clinical

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intrathoracic portion of the stomach immediately below it are best visualized by fluoroscopy in the head-down, supine, right anterior oblique position. The barium must be swallowed with the patient inverted. A definite diagnosis is made only by removing a bit of gastric mucous membrane just below the point of narrowing, through an esophagoscope. This is usually at the level of the seventh dorsal vertebra (Findlay and Kelly; Monkhouse and Montgomery; Marks, 1937). In Schilling's case (1932), in a 75-year-old laborer, the condition was associated with a double aortic arch, the larger branch of which lay posterior to the trachea and esophagus.

Other Congenital Defects.—Mucchi (1935) recorded a rare congenital anomaly in which a right aortic arch occurred posterior to the esophagus.

Sauerbruch and Fick (1931) successfully removed an embryonic cyst of the esophagus which had caused serious dysphagia, dyspnea, and palpitation of the heart in an undersized, poorly nourished boy 13 years of age. A plum-sized mass was found on the anterior wall of the esophagus, about 5 cm. above the cardia. This was excised without opening the esophagus. Recovery was complete, symptomatically and roentgenologically, although convalescence was complicated by empyema.

Kirklin's (1932) demonstration, by roentgenography, of an instance of unusual prolongation of the esophagus below the diaphragm, emphasizes the fact that there may be considerable variation (Bársony and Koppenstein, 1935) in the length of the intra-abdominal portion. Kirklin assumed a congenital anomaly in his case. Herzberg (1934) pointed out that the angle of entrance of the esophagus into the stomach may vary greatly.

ACHALASIA OF THE CARDIA

The work of Hurst (1925, 1934), Rake (1926, 1927), and Cameron (1927), focused attention on degeneration of Auerbach's plexus as the underlying pathologic change in practically all cases of so-called "idiopathic dilatation," "cardiospasm," "phrenospasm," or "achalasia of the cardia." Their work has been quite generally accepted (e.g., Beattie, 1931; Scrimger, 1931; Etzel, 1934), although in Wright and Freeman's case (1934), Auerbach's plexus was said to be normal. As a rule, the vagus trunks are unaffected (see Ewald, 1907; Zaaier, 1920; Etzel, 1934; and, for a well-known exception, Kraus, 1902).

The cause of the degeneration in the fibers and ganglion cells of Auerbach's plexus is not entirely clear. Partly on the basis of experimental work and partly as a result of clinical and post-mortem observations, Etzel (1935, 1937) came to the conclusion that this degeneration is due to a chronic deficiency in vitamin B₁. The occasional coincidence of megacolon (Bignami, 1931; Ledoux-Lebard, Nemours-Auguste and Lefebvre, 1936; Martini and Comas, 1937), in which regional degeneration of Auerbach's plexus is also present (Etzel, 1934, 1935, 1937), provides additional evidence of a generalized nutritional origin in achalasia.

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A fairly large number of cases of achalasia have been seen in infants and children. Among recent interesting cases may be mentioned those of Rebattu and Mayoux (1925) in a boy, 12 years of age, who had had symptoms from the time of weaning; of Häggström (1930) in a male, aged 30 years, whose symptoms began in childhood; and of Boppe (1935) in a boy 13 years of age, whose dysphagia of twelve years' standing was relieved by a Heller extramucous esophagotomy. Phelps (1930) reported three cases in infants, all improved by bougienage. It is natural to label these congenital (e.g., Gonzalez, 1933), but possible factors, such as intrauterine or post-partem infections, or vitamin deficiencies, should not be lost sight of. Van Gilse (1928) suggested as the cause of the dilated esophagus in his small patient a birth injury with damage to the vagus centers. Gerlings (1936) noted that in interpreting the fluoroscopic appearances it is necessary to recognize that in infants the esophagus is normally relatively large and there is much aerophagia (see also, Aimé, 1937). When solid food is taken on weaning, the condition usually disappears. Gerlings thinks the infantile state may persist in some cases as "congenital spasm of the lower esophagus."[†]

Experiments have shown that in dogs complete division of one vagus nerve and partial destruction of the other result in a condition which simulates achalasia (e.g., Ozorio de Almeida, 1929; de Vasconcellos, 1934). The vagus impulses apparently (1) increase tone and peristalsis in the esophagus, and (2) elevate and enlarge the cardiac orifice by contracting the outer, longitudinal muscle coats (see von Mikulicz, 1903; Scrimger, 1931). When Auerbach's plexus is partly or wholly destroyed, the esophagus becomes irregularly active and later quiet, and

observation of "heartburn" in patients with achlorhydria. Vinson (1923) stated that esophageal obstruction, especially cardiospasm, should always be suspected when there is epigastric pain which suggests gallstone colic or angina pectoris. On the other hand, this type of pain just as well may be caused by spasm secondary to ulceration of the esophagus (Barclay, 1915; Connolly, 1934).

Wallis (1934) described a case of functional spasm of the upper esophagus in an infant during the first year of life. Carlson (1922) gave an account of temporary local spasm with dysphagia in a laboratory worker whose pharyngeal and esophageal mucosal membranes were burned with sodium hydroxide. Friedrich (1934) described an instance of diffuse esophageal spasm due apparently to compression of the ninth and tenth cranial nerves and the medulla by advancing osteitis fibrosa at the base of the skull. McGibbon (1935) and others have reported cases of dysphagia with anemia which should be kept in mind when no organic cause for the distressing symptoms can be found. The syndrome, which occurs as a rule in young women, is said to be due to a deficiency of vitamin B₁₂ and responds readily to dilatation of the esophageal entrance and the administration of large doses of iron and a well-balanced diet.

[†]These young patients, and occasionally older ones, sometimes exhibit esophageal changes which seem to be due to improper functioning of the vagus fibers, but which do not fit into the usual picture of achalasia. Kelly (1935), in 100 consecutive autopsies on infants and young children, found in three male subjects great dilatation and atrophy of the musculature of the esophagus below the level of the trachea. The cardia, instead of being obstructed, was unusually wide open. The stomach was thin and smooth. In a later article (1936) he reproduced drawings from these most striking cases of fatal malfunction. Negus (1936) found a similar condition in an infant, aged 6 weeks, the cause of which he could not determine; the cells of Auerbach's plexus did not appear to be degenerated. Abell (1930) reported a possibly similar condition in a woman, aged 62 years, whose gastric contents flowed freely into the greatly dilated esophagus whenever she lay down, but which, when she stood up, emptied into the stomach again. At operation, Abell narrowed the diaphragmatic hiatus so that it admitted only the tip of the index finger. The symptoms were relieved for five years.

the cardia fails to open normally in response to an oncoming bolus of food (e.g., Tamiya, 1929; Tamiya and Tamura, 1931). The role of the sympathetic fibers is not entirely clear, but it seems likely that in general they regulate the activities of the vagus and that they are responsible for the tone of the circular and oblique smooth muscle fibers in the region of the cardia (Ohsawa, 1933).

Other factors which have been brought forward as of etiologic importance in achalasia may be secondary; for example, overaction, faulty action, or position of the diaphragm. Jackson, in his books (1907, et seq.), Bassler (1914), Joannides (1929), Peroni (1937), and a few others speak of phrenospasm as a possible cause of the disease. It should be noted that Jackson does not exclude other possible causes, but he believes the disease as a rule to be "simply the failure of the diaphragmatic pinchcock to open normally in the deglutitory cycle." MacLeod (1937) reported a case in which a high left diaphragm, which apparently was elevated by distention of the colon and fundus of the stomach, seemed to distort the lower esophagus enough to cause partial esophageal retention. Graham, Singer, and Ballon (1935) reproduced the film of a patient who developed typical "cardiospasm" two months following left phrenicectomy for bronchiectasis. The significance of this unusual observation (Balloon, Wilson, Singer, and Graham, 1930), is not clear, but, at any rate, phrenospasm can scarcely have been the cause of the condition. Furthermore, it is well known that paralyzing the phrenic nerve does not relieve achalasia. On the contrary, in the case of semisolid and solid foods, the emptying of the esophagus is aided normally by the milking action of the crura of the diaphragm (Fulde, 1934). Most observers (e.g., Bárony and Wald, 1938) agree that in achalasia the initial obstruction is below the level of the crura of the diaphragm. If the vagus fails, because of damage to Auerbach's plexus, the oncoming food collects in a somewhat atonic esophagus, and the cardia, possessed of its normal tone, does not open, even though the diaphragm is active. Later on, the diaphragm may be of considerable importance in aggravating the condition because, if the disease has progressed sufficiently, the dilated esophagus hangs over its sharp edge, in this way forming a dependent undrained sac which by hydrostatic pressure distorts and collapses the channel into the stomach. Mosher (1927) concluded that the pressure of the expanding lung tips and the obliquity of the hiatal portion of the esophagus have much to do with irregularities of emptying. In the worst cases the esophagus may become tortuous and S-shaped and the lowest loop may hang far below the diaphragmatic hiatus and cardia (Heyrovsky, 1912; Lambert, 1914; Scrimger, 1931). Naturally, in such a case the secondary mechanical factors, distortion and gravity, far outstrip the original achalasia as elements of importance in the obstruction. Any treatment which fails to take them into consideration is futile.

Much of the edema, fibrosis, and ulceration which occurs in achalasia results from obstruction, stasis, and putrefaction (e.g., E. E. Graham, 1919; Charbonnel and Massé, 1932). The diverticula which not infrequently form in cases of achalasia may be the result of stasis, although it is just as reasonable to say that the diverticula were present first and caused the spasm of the cardia reflexly (see Fitzgibbon, 1928).

A considerable number of reports have appeared from time to time which encourage the use of drugs in the diagnosis and therapy of various spastic and atonic states of the esophagus, including achalasia. Papaverine hydrochloride, which acts directly on smooth muscle to diminish its tone, appears to have a favorable effect in some early cases of achalasia (Stein, 1915). In a case of "cardiospasm" Howarth (1922) stated that 4 gr. of papaverine injected subcutaneously caused almost immediate relaxation of the cardia and the whole bismuth meal was in the stomach within five minutes. Doumer and Cuvelier (1937) found this drug, given by mouth, one-fourth hour a.c., t.i.d., 20 drops of 2 per cent solution, undiluted, very effective for relief of spasm in achalasia, ulcer, or carcinoma. On the other hand, Tamiya, Kawashima, Inada, and Fuzimura (1929) stated that in two of their patients the dilated esophagus did not empty after papaverine alone, even though the peristalsis increased and the tone of the lower esophagus and cardia decreased. Only if adrenalin or a sequence of papaverine-adrenalin were used did the barium pass into the stomach with certainty. If adrenalin was injected first, papaverine failed to empty the esophagus. Guns (1928) found that in normal human beings atropine produces spasm in the region of the cardia. Atropine and belladonna appear to be of no use in achalasia, although they are often beneficial in spasm of the esophagus at higher levels.

The experiences of Canfield (1937) are worth noting. In two cases of achalasia complicated by very serious esophagitis the inflammation was gradually improved by washing the esophagus out daily for an extended period. In both cases dilatation was eventually carried out safely, with complete relief of all symptoms. Bull (1925) and others have emphasized the importance of thorough cleansing of the esophagus before any operation for achalasia, or, for that matter, before any operation on the gullet.

In America, surgical relief for intractable achalasia has been resorted to less often than in Europe. It should be noted, also, that even in Germany Lotheissen (1934), in an extensive experience covering a period of many years, has never found operative methods necessary, although he remarks that if he did not succeed by dilatation in a case he would use them. Possibly the results obtained by repeated dilatations have been better on the average here than abroad (Plummer, 1912; Smithies, 1930; Nagel, 1936, 1938). It is quite certain, though, that a fairly large number of chronic invalids, perhaps one to three in every

large city, deserve further treatment by operation. These patients, with large, dependent esophageal sacs, usually have been dilated without permanent relief, and, as noted previously, the mechanical situation is such that little could be expected except by operation. The Mikulicz (1904) method of dilatation with the fingers or an instrument, introduced from the stomach, is ineffective except in uncomplicated cases in which endoscopic dilatation by a bag would do just as well. Wendel's (1910) open esophagoplasty, and Heller's (1913) extramucous esophagocardioplasty, when used in the advanced cases, can only be successful if the redundant esophagus is straightened out by pulling its sagging lower portion from the thorax into the abdomen.

The Heller operation still has many advocates, especially in Southern Europe (e.g., Delbet, 1929; Oberthur, 1931; Iacobovici and Hanganut, 1931; Charbonnel and Massé, 1932; Soupault and Hamburger, 1933; Pieri, 1933; Desplas and Camelot, 1937). Zaaizer (1929) had no deaths following eight Heller operations, and Rieder (1931) none in six. In 1933, Ohsawa reported 6 successful Heller operations by the transthoracic route; there were no failures. Very few late reports are available on these operations, but the emphasis which some authors (Fruchaud, 1934; Desplas and Aimé, 1936) placed on the necessity for making a very long extramucous incision indicates that there have been unsatisfactory results. Charbonnel and Massé note that Delbet's patient required a second operation. In a few cases cicatrization has occurred, narrowing the lower esophagus and necessitating esophagogastrostomy (e.g., Küss, 1936). Two of Turner's patients (1931), operated upon by the Heller technique, had recurrences and one of these was subsequently cured by an open cardioplasty of the Heineke-Mikulicz type. Knight (1936) was disappointed in the results of two Heller operations. Scrimger (1931) recorded a successful result by this method, but another patient died of mediastinitis following inadvertent perforation of the mucosa. Thereafter, in three cases Scrimger simply freed the esophagus, brought it down and straightened it out, and cut the crura, as first suggested by Bassler (1914) and subsequently practiced by Charbonnel and Massé. The results were good and he believes the extramucous esophagocardioplasty portion of the Heller operation is not essential. Turner (1931) operated upon five patients by the method of the French surgeons (Tuffier, 1922; Hartmann, 1929), loosening the esophagus and bringing it down without incising the muscular layer, and only one patient obtained anything like permanent relief, but it should be noted that he did not divide the crura of the diaphragm.

The operation which has found most favor in Europe has been Heyrovsky's (1912) esophagogastrostomy by the abdominal route. Fromme (1929) said that it carries a negligible mortality. Häggström's (1930) collected statistics are of great interest: Heyrovsky's

operation had been done in twenty-nine cases by thirteen operators, with no deaths and with good functional results in all. According to Häggström, the same operation when done by the thoracic route had resulted fatally in two of 5 cases; an additional patient developed empyema postoperatively but recovered. In another patient, operated upon by the transthoracic route (Breitner, 1930), adhesions were dense and the exposure imperfect. The patient recovered from a localized empyema, but the functional result of the anastomosis was poor. The author thought that the abdominal approach would have been more favorable. On the other hand, von Haberer (1930) was unable to complete an Heyrovsky operation by the abdominal route. At a later left-sided thoracotomy, it was seen that the dilatation began a hand's breadth above the diaphragm. A successful esophagogastrostomy was performed. Naegeli (1930) referred to a fatal transthoracic esophagogastrostomy. Six Heyrovsky esophagogastrostomies via the abdomen were performed successfully by Turner (1936), although one patient required a secondary operation because of closure of the stoma; in the same article, Knight reported three more satisfactory esophagogastrostomies; another favorable case was referred to by Nehrkorn (1930).

It is plain that, when an esophagogastrostomy is done by the abdominal route, the operator of necessity must enlarge the hiatus, mobilize the redundant lower esophagus, and bring it well below the diaphragm, before he can make an anastomosis easily and safely. In this way the esophagus is automatically straightened and the crura may be divided. Much of the success of this operation is undoubtedly due to these factors. In a few instances reference is made to the necessity of making a large anastomosis and to the importance of leaving no spur behind which esophageal contents can stagnate. Such cautioning statements always indicate imperfect functioning which the author thinks can be improved upon.

In the operation by Lambert (1914) the redundant esophagus was brought down into the abdomen and sewed all around to the diaphragm. Through a gastrostomy opening, a long clamp was partly closed with one blade in the esophagus and the other in the stomach. The handles were brought out of the wound and gradually approximated. The clamp sloughed through on the ninth postoperative day. An x-ray study, four months later, showed that the esophagus emptied well and was much smaller. Lambert's operation resulted in a sort of "Finney pyloroplasty," which provides a large anastomosis without a spur. This same effect was obtained by Frey (1932, 1938), who, by a transthoracic approach, freed the greater curvature of the stomach and sutured a broad surface of fundus against the anterior half of the dilated lower esophagus without tension. He then opened the anterior wall of the stomach, divided the broad spur he had fashioned, and sewed it all around from the inside, in this way completing a "Finney pyloroplasty" in another

way. The anterior wall of the stomach was closed and the anastomosis was placed below the diaphragm. No drainage was used; fluid did not accumulate in the pleural cavity, and the result was excellent.

Gröndahl (1916), Bull (1925), Scandinavian surgeons, and Watts (1923), of Virginia, performed abdominal cardioplasties by a technique similar to Finney's for the pylorus. Bull emphasized the importance of widening the hiatus by severing the pillars of the diaphragm and of straightening the esophagus out and bringing the lower portion into the abdomen, where it was sutured to the diaphragm. The anastomosis was then done below the diaphragm, using a U-shaped incision which made a wide opening without a spur, and was very satisfactory. Four operations of this kind have been reported in this country, two by Churchill (1935) and two by Womack (1938). On the whole, this procedure appears to be safe and gives the best results of any proposed.

Except in patients of the extreme dolichomorphous type, the abdominal approach for operations at the cardia is not particularly difficult for surgeons who are accustomed to work high in the upper abdomen (see Herzberg, 1934). Only rarely is it necessary to mobilize the seventh, eighth, and ninth cartilages on the left (see Marwedel, 1903, and description of Ohsawa's technique later in article). Usually a midline incision from the ensiform to the umbilicus and mobilization of the left lobe of the liver by dividing the coronary ligament (Lambert, 1914) give adequate room in which to work. The redundant esophagus can easily be brought into the abdomen. Sauerbruch and his pupils (see Krauss, 1933) are the strongest advocates of the transthoracic operation. Grégoire (1932) and Braine (1932) have used an extrapleural, extraperitoneal approach extensively and with satisfaction: a U-shaped incision is begun paravertebrally over the left eighth rib, curved downward to the twelfth rib, and back up to the eighth in the posterior axillary line, resecting the twelfth rib, dividing the eleventh anteriorly and posteriorly, and the tenth and ninth posteriorly only. By dissecting extrapleurally and extraperitoneally, excellent exposure is obtained of the lower esophagus, diaphragm, and cardia, according to the authors. Braine reported six successes and no failures with Heller's operation, using this exposure.

Another type of operation which at first thought seems promising aims to interrupt the sympathetic impulses which flow to the region of the cardia. If sympathetic innervation is responsible for normal tone at the cardia, division of the sympathetic fibers might relieve obstruction in achalasia by paralyzing the constricting muscle there. In 1934, Craig, Moersch, and Vinson successfully treated a patient with intractable cardiospasm, accompanied by pain in the left chest, shoulder, and arm, by bilateral cervicothoracic sympathetic ganglionectomy. As a result of their experiments on cats, Knight and Adamson (1935) became convinced that denervation by excising the left gastric artery and the im-

mediately adjacent omental tissues running up to the base of the esophagus should remove the sympathetic control of the cardia and cure achalasia. In their cats, bilateral vagus excision resulted in achalasia, but, if the thoracic sympathetic chains were removed at the same time bilaterally, no obstruction occurred. They reasoned, therefore, that the activity of the sympathetic fibers is essential for obstruction. In the cats, after production of achalasia by bilateral excision of the vagi, a celiac sympathetectomy gave complete relief from the obstruction, as shown by fluoroscopic studies. Eight patients with achalasia were operated upon similarly (four of these by Adamson), but the results were not very good (Turner and Knight, 1936). Two patients of Souttar's (1935) were benefited by the operation. Stubbe (1937) also reported an improvement; the esophagus was still dilated ten months after operation, but barium entered the stomach freely. It is interesting to note that sympathetic denervation, as carried out by Adamson and Knight, does not result in regurgitation from the stomach into the esophagus.

Carlson, Boyd, and Pearey (1922) and Caballero (1923) demonstrated in dogs and cats a motor and inhibitory innervation of the cardia and lower esophagus via the splanchnic nerves (see also Fulde, 1934). This was further substantiated by Woollard (1935), but he warns the surgeon against expecting clean-cut results from surgery in this field. His anatomic studies, extended by Mitchell (1938), show that sympathetic fibers may reach the esophagus in at least three ways: (1) from above, having entered the vagi from the cervical sympathetic chain; (2) from the inferior cervical and thoracic sympathetic ganglia (only a few fibers); (3) from the celiac plexus, from which fibers may travel in company with the left gastric artery to the region of the cardia. From the work of these authors, it seems unlikely that any operation of reasonable magnitude will effectively remove the sympathetic supply to the cardia. Furthermore, it seems doubtful to me that denervation would benefit patients with advanced degrees of the disease in which the mechanical factors are prominent; whereas, in the early cases endoscopic dilatations are more easily carried out and are at least as effective.

On the basis of experiments on dogs, de Francesco (1934) concluded that, by injecting alcohol locally or by interrupting all of the nerves by stripping off the longitudinal muscle layer, he could produce a loss of tone and peristalsis of the lower esophagus, and also, temporarily, of the cardia. Recalde (1932) cured three out of four patients operated upon by stripping away the longitudinal muscle layer; the other patient died of subphrenic abscess, the result of perforation of the mucosa at operation. Mitchell (1938) is of the opinion that the improvement in Recalde's patients may be due to mechanical rather than neurological effects.

The importance of the differentiation of achalasia from carcinoma, cicatricial stricture, impacted foreign body, epicardial diverticulum, and hiatus hernia is discussed by Mikulicz (1904), Plummer (1912), Vinson (1923, 1936, 1938), Vinson and Moersch (1928, 1935), and Roessler (1935).

DIVERTICULA

Pharyngeal diverticula are not, of course, esophageal lesions, but the sacs hang down against the esophagus and for practical purposes may be considered as such. They outnumber true esophageal diverticula, but nevertheless are comparatively rare. These pouches are hernias of the lower pharyngeal mucosa which protrude, usually in elderly males, through a weak spot between the muscle fibers, usually in the midline, immediately above the cricopharyngeus muscle (Moynihan, 1932; Lerche, 1936).

Credit for the reduction, almost to the vanishing point, of the mortality rate following surgical removal of these sacs must be ascribed to the special interest shown by American surgeons (Mayo, 1910; Murphy, 1916; Judd, 1918; Judd and Phillips, 1934; Lahey, 1933, 1937; Lahey and Hoover, 1937; Gaub and Jackson, 1915; Torek, 1921; Eliason, 1923; Babcock and Jackson, 1931, 1936; Perrone, 1936; Eliason, Tucker, and Thigpen, 1937), but the very important contribution of the two-stage operation was made by the German, Goldmann (1909). The danger of mediastinitis, originally a serious hazard following the one-stage operation, is no longer great for those who are patient enough to carry out a specialized technique with nicety. However, for maximum safety to the patient in any case, and for the occasional operator in this field in all instances, the two-stage procedure is advisable.

Careful roentgenologic and esophagoscopy studies are indispensable before operation. In several instances of carcinoma an erroneous diagnosis of pharyngeal diverticulum has been made (Clerf, 1932). Carcinoma has been discovered in the sac of a pharyngeal pouch (Raven, 1933).

The elderly patients are often in a state of poor nutrition. Vinson (1925) advised against preliminary gastrostomy, but said that by a suitable technique a silk thread can always be passed, after which a catheter may be guided into the stomach for preoperative feedings. Local anesthesia is all that is necessary (Sturgeon, 1929). A catheter in the esophagus helps lead the operator to the sac. A bougie (Kingman, 1923) or an esophagoscope (Gaub and Jackson, 1915) within the sac itself is a still better guide. Whether a one- or two-stage operation is used, it is very important to dissect the pouch out completely so that a residual pocket will not be left. It is equally important not to narrow the lumen of the esophagus by excising a portion of the normal wall. A stomach tube (Metheny, 1935) or esophagoscope in the esophagus at the time of removal is of assistance in preventing this. For about ten

days after operation, patients should be fed by a tube passed through the nose into the stomach (Krekel, 1923; Crile and Dinsmore, 1924). If there is tendency toward spasm or stenosis, postoperative dilatations should be carried out at intervals for a year or more. Lahey (1933, 1937) found this quite often necessary following his two-stage operations; whereas, Jackson and Jackson (1933), and Eliason, Tucker, and Thigpen (1937) reported no obstructive symptoms after the one-stage operation aided by the esophagoscope.

For patients in whom operation is refused or contraindicated, Moersch and Judd (1934) advised the periodic passage of sounds, a thread always being used as a guide. For patients who are not good subjects for a complete operation, the expedient of Liebl (1910), Schmid (1912), and König (1922) of freeing the sac and fixing it in a cephalad direction so that it will drain may be used. Recurrence is common after this operation (see Jackson and Jackson, 1933), but a few symptomatic cures have been obtained in a very safe manner (e.g., Schwarz, 1935). For small pharyngeal diverticula, Lotheissen (1931) used Girard's (1896) method of progressive infolding of the sac with two or three purse-string sutures, followed by a transverse row and the suturing of the stump against the thyroid gland (see also Bevan, 1917, 1921). Inversion of the sac into the pharynx, with or without the removal of the sac transorally with a snare (McClure, 1934; Ross, 1937), may lead to serious consequences from laryngeal obstruction.

Oehlecker (1937) reported an unusually large pharyngeal diverticulum in a male, aged 70 years, who had had dysphagia for twenty years. At the first operation, the neck of the diverticulum was divided, the pharynx closed, and the sac drained by a tube in the right supraclavicular fossa. Because of the foul discharge, the pouch was later partially removed through a right posterior mediastinal approach. At a third operation, the remainder of the sac was excised, but pneumonia resulted in death.

Guisez (1925) and others have expressed the opinion that most diverticula of the midesophagus arise as the result of contraction of adjacent scar tissue, usually tuberculous. He saw one case in the upper third which resulted from a bullet wound; as the sinus cicatrized, a diverticulum formed. Herzog (1933) presented two examples in which traction diverticula were seen to arise following roentgen therapy for intrathoracic tumors. He explained them on the basis of regression of exudative inflammation about the esophagus, with resulting traction on the walls by scar tissue.

Wallace (1937), in a study of twenty-six cases of traction diverticulum of the midesophagus, found that more than one-third of the patients had symptoms (pain in six, dysphagia in six, hematemesis in three). Some of the smallest sacs caused trouble and some of the largest, none. Most authors (e.g., Heacock, 1930; Herskovits, 1938; Sturtevant, Sha-

piro, and Wallace, 1932) are under the impression that symptoms are usually absent in this lesion. Sturtevant, Shapiro, and Wallace and Lotheissen (1931) emphasize the occasional occurrence of complications, such as cancer or perforation with mediastinitis or pulmonary gangrene.

Guisez (1925); Jackson and Jackson (1933), and Macmillan (1935) ascribed pulsion diverticula of the lower esophagus to the effects of increased esophageal pressure secondary to obstruction lower down, as from achalasia, congenital webs, or inflammatory stenosis. Elward (1936) reported a case in a patient with an hiatus hernia. The association of diverticulum with achalasia, and the possible interdependence, was pointed out by Hurst (1925), M. K. Smith (1928), and Lotheissen (1931). On the other hand, L. A. Smith (1928) found among nine patients with diverticula of the thoracic esophagus only one in whom there was any evidence of achalasia. Schmidt (1936) considered several small diverticula found incidentally at autopsy in a boy, aged 7 years, to be congenital in origin. Lerehe (1936) believes that diverticula usually arise in certain areas along the wall of the esophagus where the imbrications of muscle fibers are thinnest, in this way affording diminished resistance to increased intraesophageal pressure.

When diverticula arise immediately above the diaphragm, diagnosis may not be immediately apparent, and even following roentgenographic and esophagoscopy studies there may be confusion with hiatus hernia or congenitally short esophagus (Marks, 1937). Haenisch (1923) found in his case that a stomach tube always curled up in the right-sided sac; whereas, in every instance of right-sided hiatus hernia which he had seen, a tube passed readily into the portion of the stomach below the diaphragm.

When diverticula occur in association with achalasia or other obstructive lesions, instrumental dilatation of the esophagus will often relieve all symptoms (Hurst, 1925; M. K. Smith, 1928; Jackson and Jackson, 1933; Nissen, 1934), but if difficulties persist surgical intervention is occasionally justified. On the basis of experimental work, Gosset (1903) and Lotheissen (1908) suggested that the distress which accompanies large epiphrenic diverticula might be relieved by trans-diaphragmatic anastomosis of the sac with the fundus of the stomach. According to Heyrovsky (1912), this was actually done by Lotheissen, but I was unable to find the account. Lotheissen (1931) referred briefly to his case and also noted that esophagogastronomies, supposedly for diverticula, were carried out by Sauerbruch and Henschen. Von Hacker and Lotheissen (1926) noted the successful removal by Willy Meyer of a sac from the lower portion of the esophagus. Clairmont (1924) excised a hen's-egg-sized epiphrenic diverticulum in a woman, aged 43 years. The sac and adjacent esophagus were displaced into the peritoneal cavity, the pouch removed, and the defect sutured in layers, with recovery. Sauerbruch (1927) reported three successful cases:

(1) a diverticulum of the lower esophagus, the size of two adult fists, in a male, aged 51 years, removed in two stages by anterior mediastinotomy; (2) a perforated traction diverticulum, removed by way of a posterior mediastinotomy following the drainage of an abscess of the lung, which it had caused, in a female, aged 27 years; (3) a large epiphrenic diverticulum in a woman, aged 48 years, with severe cardiospasm of long standing, excised, the defect closed in two layers, and a flap of paralyzed diaphragm sewed over the suture line. In this case the sac was removed instead of anastomosing it to the stomach because the lower pole could not readily be approximated to the fundus. The symptoms of cardiospasm were completely relieved by the removal of the diverticulum.

Quartero (1931) reported the successful removal by P. A. Vos of a very large diverticulum from a male, aged 40 years, who had suffered from dysphagia since the age of 5. The immense sac lay against the dome of the diaphragm. Because of its position on the right, it was impossible to unite it with the stomach. The resection was carried out by removing the tenth and eleventh ribs posteriorly. The neck was closed with a double row of sutures. After eight days, a fistula appeared in the wound, but it healed eventually, and 6 months later the patient was well. Barrett (1933) recorded a successful resection by W. H. C. Romanis in a woman, aged 59 years, who for two years had suffered from a sense of fulness in the chest and progressive loss of weight. A large pouch was seen by x-ray, with the neck at the level of the seventh rib posteriorly. A right-sided pneumothorax was given and two days later ether was administered intratracheally. A bougie was passed into the sac and left there as a guide. By a transpleural exposure through the sixth interspace, the sac was found to open by a wide mouth into the right side of the esophagus, above the level of the azygos vein. It was thick and fibrous and stretched vertically downward for $3\frac{1}{2}$ inches along the esophageal wall. After freeing it, the neck was crushed with a Parker-Kerr clamp, divided with a diathermy knife, and closed with two layers of catgut sutures. A small flap of the parietal pleura was cut to cover the suture line and the thorax was closed without drainage, with lungs expanded. Atropine was provided in large doses for forty-eight hours, and the patient was fed through a transnasal gastric tube for nine days. Fluid accumulated temporarily in the right pleural cavity, but was reabsorbed. The patient was well six months later and roentgenography showed a normal esophagus.

By inverting a thumb-sized diverticulum into the lumen at the level of the root of the lung, Turner (1936) attempted to avoid the dangers of opening the esophagus. He used a posterior extrapleural approach, but injured the pleura accidentally and the patient died of a severe septic pneumonia and empyema with a bronchopleural fistula. At autopsy the infolded diverticulum was found to have become only a

prominence. Portis (1921) reported on an epiphrenic diverticulum for which surgical removal seemed indicated. Lahey (1937), carrying out the suggestion of König (1922), approached a troublesome mediastinal diverticulum transpleurally and sutured the liberated sac in an inverted position so that it remained empty. This appears to be a simple, safe, and effective procedure, probably applicable only to small thoracic diverticula.

BENIGN TUMORS

By 1932, according to Patterson, only 61 cases of benign tumor of the esophagus had been reported, of which 26 were polyps, 8 papillomas, 2 fibromas, 2 lipomas, 1 lipomyoma, 8 myomas, 6 leiomyomas, 2 adenomas, 1 hemangioma, 3 epithelial cysts, 1 dermoid cyst, and 1 aberrant thyroid. A rather large number of the growths had been found incidentally at autopsy, but others had caused dysphagia or obstructive dyspnea. Several of them were regurgitated with dramatic results. In Patterson's own case, in a male, aged 54 years, a mass repeatedly came up into the back of the throat, then disappeared. The tumor, a myxofibroma, was found to be attached to the left wall of the esophagus, 2 cm. below the pharynx. The narrow pedicle was severed with some difficulty with forceps. In the case of Garretson and Hardie (1928), a pedunculated fibrolipoma, 15 cm. long and 1.5 cm. in diameter, was vomited up during a Bárány test and was removed with a tonsil snare. The authors remarked that the dragging action of peristalsis tends to elongate such masses. Weyrich (1933) reported an autopsy on a man, aged 58 years, who, without premonitory symptoms, strangled suddenly. Attached to the wall of the esophagus at the level of the first thoracic vertebra was a lipoma with a narrow neck which extended upward for 9.5 cm. to the entrance of the larynx. Here the swollen, edematous end of the tumor had blocked the airway.* Chitty (1938) presented a Chinese male, aged 26 years, who, during a fit of coughing, expelled a long, fleshy polyp for a distance of seven inches beyond his teeth. The pedicle, attached at the junction of the pharynx and esophagus posteriorly, was severed after opening the esophagus by a cervical incision. Healing was delayed by suppuration, but the outcome was good, without stricture.

Ginsburg (1931) noted that papillomas of the esophagus are usually single and pedunculated; however, in two cases, including his own, they had been multiple. He had removed them, relieving the dysphagia. Hunt (1937) added a similar case of papillomas in a woman, aged 70 years, who because of moderate dysphagia had passed a stomach tube on herself for a period of thirty years. Whether or not the resulting chronic inflammation had an etiologic bearing was questionable.

*A less serious degree of obstruction, of a similar nature, occurred in a case of McClure's (1931) following the inversion at operation of a hypopharyngeal diverticulum.

In reporting two cases of myoma of the esophagus associated with diverticula, Stewart (1931) suggested that mechanical effects due to the presence of the myomas may have caused the diverticula. In an autopsy on a male, aged 74 years, multiple, pea-sized myomas were found at the junction of the upper and middle thirds of the esophagus (Rose, 1936). Moderate obstruction, dilatation and hypertrophy above them, and some hypertrophy below them were thought possibly to be the result of dysfunction of the muscle-nerve mechanism brought about by the presence of the tumors.

Moersch and Broders (1935) reported an adenoma, one of the rarest of the benign tumors of the esophagus, in a male, aged 48 years, who also suffered from a duodenal ulcer. Eleven months after the original observation, no advance was to be seen in the extent of the lesion. The patient did not elect surgical treatment.

Cabot case No. 23491 (1937) records the story of a girl, aged 19 years, who had had pain over the lower sternum for two years and difficulty in swallowing solid foods for 8 months. Roentgenography showed at the level of the fifth to eighth dorsal vertebrae a round, soft tissue mass which seemed attached to the esophagus and pulled it to the right. The mucosal relief, however, appeared normal. At operation, by a right transpleural approach, the tumor was shelled out of the wall of the esophagus without injury to the mucosa. It was a firm, fibrous, perfectly encapsulated fibroma which microscopically presented whorls of cells and palisading, suggesting a neural origin. There were no mitotic figures.

In an autopsy on a patient with cirrhosis of the liver, Carnot, Rachet, and Delafontaine (1929) found in the midst of many venous varices of the lower esophagus a lentil-sized, multilobed, pedunculated arterial nevus. The authors referred to Bouchard, Claude, and Gilbert, all of whom related arterial nevi, especially the cutaneous ones of the trunk, to cirrhosis of the liver. By the application of radium, Guisez (1913) cured an angioma which had almost completely obstructed the lower esophagus in an elderly male. Broders, Vinson, and Davis (1933) described a case of hemangioendothelioma of the esophagus in a female, aged 76 years. She had had dysphagia and substernal pain for six weeks. X-ray and esophagoscopy showed an infiltrating lesion invading the left anterior wall of the lower esophagus.

For benign pedunculated tumors of the esophagus, Lotheissen, as early as 1899, recommended removal through an esophagoscope. Von Hacker and Lotheissen (1926) noted that even the benign growths often recur. The tumors must be removed completely, but the esophagus must not be perforated while doing this. Guthrie (1931) referred to a child, 8 months old, from whom a pedunculated, cystic swelling resembling a nasal polypus was removed from the upper esophagus by snaring.

Benign growths which cannot be removed through the esophagoscope rarely have caused symptoms of sufficient severity to justify external operation, but Ohsawa (1933) recorded the removal, by free left lower thoracotomy, of a myoma of the lowest portion of the esophageal wall. The patient was a Japanese woman, aged 43 years, who had suffered from dysphagia for twenty-four years. Following excision of the tumor, which was accomplished without opening the lumen of the esophagus, Ohsawa closed the muscle wall transversely. The patient experienced complete relief. Krauss (1933) reported from Sauerbruch's clinic in Berlin the removal of a nodular fibromyoma, the size of a small fist, from a man, aged 33 years, who had had dysphagia of increasing severity for three years. Roentgenograms showed a large, rounded, benign defect in the lower esophagus. The tumor was exposed by an abdominothoracic incision. The lumen of the esophagus was opened during the removal and was then sutured. Fearing a stricture, a short-circuiting esophago-gastrostomy was added. Feedings were given temporarily by jejunostomy and recovery was rapid. Subsequent x-ray studies showed the anastomosis unnecessary and nonfunctioning.

Watson and Bancroft (1936) reported an instance of hypertrophic cricopharyngeal stenosis in a woman, aged 49 years, which, though entirely resistant to bouginage, was relieved by an extramucous incision, similar to the Ramstedt operation for hypertrophic pyloric stenosis. The pathologic picture was that of edema and fibrosis with hypertrophy and degeneration of the striated muscle fibers.

Wood (1932) demonstrated a specimen of esophagus, from a male, aged 69 years, which showed marked hypertrophy of the muscular wall in the lower third with narrowing of the lumen. The lesion was difficult to classify because microscopic sections showed no lesions in the muscle, ganglia, interstitial tissue, or mucous membrane. The possibility of vagus irritation as the cause of the hypertrophy might be considered.

(To be continued in the November and December Issues of the JOURNAL. The references will accompany the last section.)

Review of Recent Meetings

REPORT OF THE MEETING OF THE PACIFIC COAST ASSOCIATION, MARCH 28-31, 1939

H. H. SEARLS, M.D., SAN FRANCISCO, CALIF.

SUMNER EVERINGHAM, Oakland, Calif., gave, as the President's Address, *Our Responsibility in Graduate Surgical Training*, in which he urged that all surgeons give thought and attention to the training of our future surgeons for their responsibilities.

Frank W. Lynch, San Francisco, Calif., spoke on the subject, *Cancer of the Uterine Cervix After Radiation—A Histologic Study*. He showed the survival curve of his very complete series of patients with cancer of the uterus and cervix, with treatment. The treatment employed was radiation combined with operative removal. Follow-up studies were maintained for 100 per cent of the patients.

Robert Stone, San Francisco, Calif., discussing Dr. Lynch's paper, mentioned the biologic happenings which take place in a cell under radiation therapy. He congratulated Dr. Lynch on his excellent cooperation with the radiologists in the investigative phase of the treatment of cancer and urged all present to take this attitude. **James F. Rinehart**, San Francisco, Calif., pointed out that the amount of differentiation in the tumor is an index of its rate of growth, the more differentiated, the slower the growth. X-ray, besides destroying cancer, increases the differentiation of the cells and thereby slows its growth. **Raymond Watkins**, Portland, Ore., pointed out the value of radium therapy first in the treatment of carcinoma of the cervix because it causes the ulcer to heal and clears up the infection, thereby lowering the mortality rate when the Wertheim operation is done later. Dr. Lynch, in closing, said that as long as the profession as a whole remains radium-minded the women of the country are far safer than they would be if they were operated upon. He pointed out that, in his operations, he was taking only early cases in young women. He performs a radical operation as soon as the cancerous ulcer heals.

The Prognosis of Malignant Papillary Cystic Tumor of the Ovary was the title of the paper given by **Lewis B. Morton**, Los Angeles, Calif. The author presented sixteen cases of papillary cystic neoplasm of the ovary which, at operation, were proved malignant. These patients were operated upon at St. Vincent's Hospital, by various members of the staff, between the years 1930 and 1934, and their progress was followed. Eight of the sixteen are living and eight have died. A detailed report of all sixteen cases was presented and a final review made which indicated that the prognosis for the ultimate survival of patients with malignant cystic neoplasm of the ovary is uniformly bad. Owing to the absence of symptoms, the disease is well advanced before the patient comes to operation. In the higher grades of malignancy, when lymphatic metastases have occurred, recurrence is almost certain to develop. In the lower grades of

malignancy, the outlook is far better, particularly if the tumor has not ruptured or metastasized. Even when these unfortunate events have occurred, there is hope for an occasional cure, or at least a prolongation of life.

In discussing Dr. Morton's paper, **Charles M. Fox**, San Diego, Calif., said that in his experience most of these tumors are decidedly malignant. He feels that aspiration of the cystic tumor is dangerous. **Otis Lamson**, Seattle, Wash., believes that, in operating for papillary cyst of the ovary, both ovaries and the uterus should be removed. He reported several cases.

Lemuel P. Adams, Oakland, Calif., showed a colored motion picture entitled *Behind the Scenes in a Modern Hospital*.

Speaking on *Acute Pancreatitis*, **E. Eric Larson**, Los Angeles, Calif., divided cases of acute pancreatitis into two types; one in which there is a transient acute attack with rather prompt recovery, and the other, the more severe and dangerous condition of autolysis known as hemorrhagic suppurative and necrotic pancreatitis, which is so rarely diagnosed except at operation or autopsy. The onset of both types of lesions is essentially the same, sudden severe pain in the epigastrium, radiating directly through the region of the upper lumbar spine and to either shoulder. There is a high leucocytosis with a varying degree of shock and cyanosis. Nausea and vomiting are usually present. At first these patients often have hypoglycemia from overproduction of insulin and later hyperglycemia from destruction of the islets in the pancreas. The measure of hyperglycemia may be considered a gauge for prognosis and treatment. No type of treatment will help those having severe hyperglycemia because the gland usually is destroyed completely. The decision as to the type of treatment must depend on an estimate of the severity of the disease. In the advanced cases the author believes abdominal operation with drainage of the pancreas offers the only chance for relief. He pointed out, however, that in many of the less advanced cases recovery takes place without surgery. He then reviewed the records of seventy-five cases of acute pancreatitis from the Los Angeles General Hospital. Forty-seven of these patients were operated upon with eighteen recoveries, a mortality of 61.7 per cent. Twenty-eight succumbed without operation and the true nature of the disease was not revealed until autopsy was done. The total mortality was 76 per cent. Though the etiology of acute pancreatitis is still not definitely known, orgies of food and liquor were discussed as possible etiologic factors and the author believes that they account for the higher incidence in the male than in the female. In his summary, Dr. Larson urged that more consideration be given to the possibility of acute pancreatitis when an acute abdominal condition is under observation.

In discussing Dr. Larson's paper, **George K. Rhodes**, San Francisco, Calif., mentioned the differential diagnosis between acute pancreatitis, acute perforation of the stomach or duodenum, acute obstruction of the gall bladder, and high obstruction of the bowel. He pointed out that the patient with acute fulminating pancreatitis has more shock and lower blood pressure than the patient with perforated ulcer or obstruction of the bowel. He advised frequent blood amylase readings. In discussing treatment, he said that conservative treatment is important until the patient recovers from the initial shock. He watches these patients carefully for the first four or five days, then, if a pancreatic cyst or abscess begins to develop, he believes in surgical intervention. In most cases the condition will subside; then the question arises as to the necessity for clearing up the chronic biliary disease which is present in probably 80 per cent of the cases. **William E. Kroger**, Los Angeles, Calif., said that, in his opinion, opera-

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Roscoe E. Mosiman, Seattle, Wash., in a paper entitled *The Significance of Subcutaneous Scar Tissue*, pointed out that the deformity with reduction of function in structures, resulting from the contractility of scar tissue, has become a major problem of modern surgery which has as its high ideal not only the healing of injury but also the restoration of structures to their normal condition as far as possible. In studying scar tissue carefully, the author noted that there were two types: (1) normal scar tissue with a complete healing process and (2) abnormal scar with continuing evidence of the irritation of tissue. The chief difference in the microscopic picture is that in the abnormal scar tissue there is an infiltration of mononuclear cells, collagen, and elastic fibers. As a result of the irritation of the tissue caused by mild residual infection, localized or fixed toxins, foreign or necrotic material, collagen and elastic fibers continue to form in the healing wound for a long period after it has been covered with epithelium. Contractility of the resultant bulk of scar tissue is more powerful than the muscle pull of the intervening joints, and deformity and loss of function result. At times there is a lack of formation of collagen fibers in the healing wound and this causes weakness and occasionally spontaneous rupture. Vitamin C is an aid to the proper formation of scar tissue. This has been proved experimentally and its absence may be the cause of the spontaneous rupture of wounds in surgical practice. It is important to minimize in every way possible the irritating factors in a wound so that the least amount of scar tissue may be deposited in the healed area. Reduction of trauma to the tissues, controlled hemorrhage in the wound, the use of nonirritating antiseptics and small amounts of suture material, complete asepsis, removal of dead tissue, and complete rest of the wound are the means used by the surgeon today to cut down reactions in the wound and thereby prevent the overabundant formation of scar tissue.

Homer D. Dudley, Seattle, Wash., as a discussant, called attention to the application of Dr. Mosiman's study to the practice of surgery and the treatment of wounds. Emile F. Holman, San Francisco, Calif., suggested that the use of vitamin C for three or four days before operation may help in the proper formation of collagen fibers and that vitamins A and B for the re-establishment of the red cells are also of value preoperatively. He urged the use of these three vitamins before operation.

Millard T. Nelsen, Tacoma, Wash., presenting a paper on *The Surgical Anatomy of Fistula-in-Ano*, gave a detailed description of the anatomy of the anal region, particularly that of the internal and external sphincters. In suggesting treatment of anal fistulas, he emphasized the need of prolonged Sitz baths. Bathing for hours each day many times will cure a patient for whom any other method is hopeless and may facilitate an otherwise difficult operative procedure. Incision should be radial from the rectal center, and Dr. Nelsen employs fistulectomy rather than fistulotomy. The two-stage procedure is necessary in deep fistulas in order to prevent incontinence; a silk ligature is tied loosely around the two sphincters and, after scar tissue has formed to back it up, the sphincters are transected, the scar tissue preventing incontinence.

Louis P. Gambee, Portland, Ore., commented on the ability of fistulous tracts in the upper gastrointestinal passages to heal, as contrasted with those in the rectum, which fail to heal.

Brien T. King, Seattle, Wash., reported *A New and Function-Restoring Operation for Bilateral Abductor Cord Paralysis*. He discussed at length the anatomy of this region, the pathologic anatomy following bilateral paralysis of the abductors of the vocal cords, and described a technique by which he has trans-

tion is indicated in most cases of acute pancreatitis. The type and degree of involvement, however, should be the determining factors in making important decisions as to whether or not to operate. **Conrad Jacobson**, Seattle, Wash., discussed the recent experimental work which has appeared in the literature. He pointed out that the prostration of these patients is away beyond that warranted by the clinical findings. He advised conservative treatment in most cases and said that, if a diagnosis is made of acute pancreatitis of the fulminating type, the condition is best left alone until it walls off.

Howard F. West and **Maurice Kahn**, Los Angeles, Calif., presented a paper on **Adenoma of the Pancreas with hyperinsulinism**; two cases in first cousins were reported, with surgical cure in one. Both patients were operated upon; in one an adenoma of the body of the pancreas was found and removed; in the other an adenoma of the head of the pancreas was not discovered until autopsy several months later. The authors observed that the symptoms of hypoglycemia, usually periodic or paroxysmal, are almost exclusively those of disturbed function of the autonomic or central nervous system. Symptoms frequently begin with vasomotor reactions indicative of sympathetic overactivity. The patient may present almost any conceivable psychic or motor misbehavior, ranging from mild euphoria to manic excitement, from mental depression to mental degeneracy, from transient weakness to paralysis, from muscular incoordination to convulsions. These symptoms are consistent with the diffuse damage found in the cells of the cerebral cortex and basal ganglia of patients who have died as a direct result of prolonged hypoglycemia. Because of this picture, these patients frequently are found on neuropsychiatric services before the correct diagnosis is made.

In discussion, **Charles T. Sturgeon**, Los Angeles, Calif., emphasized the need for a very thorough study of a patient before subjecting him to surgery when adenoma of the pancreas is suspected. He pointed out that removal of pancreatic tissue itself is not helpful and that, if the adenoma is not found and removed, the patient is not relieved. He discussed two cases in which no improvement followed the removal of part of the pancreas which did not include the tumor. **Emile F. Holman**, San Francisco, Calif., reported a case of the removal of a large portion of the pancreas without relief. **Robert D. Forbes**, Seattle, Wash., reported a case of adenoma of the pancreas and hyperinsulinism in his own practice. He could not feel the adenoma, but he removed about two-fifths of the body and tail of the pancreas and found the adenoma in the removed specimen. The patient was cured.

Alson R. Kilgore and **Glenn F. Cushman**, San Francisco, Calif., presented **Appendicostomy for Ulcerative Colitis**. The authors reported good results in ulcerative colitis by the use of appendicostomy.

J. H. Woolsey, Woodland, Calif., discussing the foregoing paper, said that he had thought that appendicostomy was obsolete, but that he was impressed by the findings of the authors and thought that he would have to use it again in the proper case of ulcerative colitis. **William J. Norris**, Los Angeles, Calif., suggested the use of partial cecectomy with eversion of the terminal ileum rather than appendicostomy for the treatment of ulcerative colitis.

Alfred O. Adams, Spokane, Wash., showed a motion picture illustrating the technique of the transplantation of full thickness and split thickness skin grafts.

In discussion, **J. H. Woolsey**, Woodland, Calif., emphasized the importance of immobilization of the graft once it was placed on the area to be covered.

conditions, particularly in those cases of overwhelming toxicity associated with tuberculous empyema. **Ralph C. Matson**, Portland, Ore., commented that he had used the flap in a number of cases.

Thomas F. Mullen, San Francisco, Calif., presented **Safeguarding the Unconscious Operative Patient** in which he pointed out the dangers which must be anticipated and prevented during the time that the patient is asleep and unable to protect himself.

This paper was widely discussed by various members of the organization. **Thomas M. Joyce**, Portland, Ore., urged gentleness in handling tissues and care in the exploration of the abdomen. He pointed out the tremendous progress in anesthesiology. **P. W. Willis**, Seattle, Wash., suggested the use of a thermometer to safeguard against overheating of the saline solution from which sponges used in the abdominal cavity are wrung. **H. G. Wetherill**, Monterey, Calif., pointed out some of the dangers of operating in higher altitudes. **Frank S. Dolley**, Los Angeles, Calif., mentioned that traction on the arm with the patient asleep may result in ulnar paralysis. **A. R. Kilgore**, San Francisco, Calif., urged the abolition of packs from abdominal surgery. **Dexter Richards**, Oakland, Calif., warned against the use of ether in the preparation of the skin before an operation which involved the use of the cautery because the ether may run down into the sheets, evaporate, and cause an explosion. In closing, Dr. Mullen left the thought that the surgeon, and the surgeon only, is the guardian of the patient's safety.

Paul G. Flothow, Seattle Wash., in **Advances and Retreats in Neurosurgery** discussed the history of the development of neurosurgery, and detailed the modern aids to neurosurgical diagnosis and advances in surgical technique, together with the development of new instruments especially designed for neurosurgical work. He then discussed the various conditions which the neurosurgeon treats.

Frederick L. Reichert, San Francisco, Calif., noted the importance of Dr. Flothow's paper in taking stock of what has been accomplished in the development of neurosurgery.

planted the omohyoid muscle into the muscular process of the arytenoid cartilage. He reported six cases in which excellent results had been obtained and showed *motion pictures of the patients and of their vocal cords in motion after treatment.*

Wallace I. Terry, San Francisco, Calif., suggested to Dr. King the use of a transverse incision of the skin instead of the one along the anterior border of the sternomastoid. He urged practice upon the cadaver of this operation, as Dr. King did, before attempting to perform it.

H. H. Searls, San Francisco, Calif., urged prophylaxis against the accident of bilateral palsy of the cords. Leo Eloesser, San Francisco, Calif., wondered how much of the relief obtained by the patient resulted from the severance of the posterior arytenoideus muscle.

A paper on *Abdominoperineal Resection for Carcinoma of the Rectum* was given by Robert A. Scarborough and Emile F. Holman, San Francisco, Calif. These authors reported a series of 95 consecutive cases, including both clinic patients hospitalized in the wards of Stanford University Hospital and private patients seen during the past four and one-half years. Four patients refused operation, though the condition was operable. Excision was performed in 69 of the remaining 91 cases, or 75.8 per cent. One operation was performed by the two-stage Lahey technique, there was one excision with end-to-end anastomosis, and in one case, local diathermy excision of a large malignant polyp was employed. These three patients are alive and well, four, three, and two years after operation. The remaining 66 patients were subjected to radical one-stage abdominoperineal resection, based on Miles' technique. There were 6 postoperative deaths, a mortality of 9.09 per cent. The authors emphasized the need of adequate preoperative preparation and discussed postoperative complications. They are of the opinion that the one-stage combined abdominoperineal resection is the ideal treatment for carcinoma of the rectum. This operation is not used to the exclusion of all other procedures, but they feel that any departure from it must be considered a concession to complicating circumstances which would render the operation unduly hazardous in the particular patient.

In discussion, H. H. Searls, San Francisco, Calif., pointed out that the more distally located carcinomas of the rectum can be removed by the Lockhart-Mummery technique and the more proximal ones by the Hartmann anterior abdominal resection. Abdominoperineal excision, therefore, may be avoided in most instances. The Hartmann procedure is less of an operation and therefore less shocking, leaves a good perineum, does not interfere with the nerve supply to the bladder, avoids the danger of impotence in the male, and carries a far lower mortality rate. Leo Eloesser, San Francisco, Calif., also gave as his opinion that the abdominoperineal operation is not necessary in all cases. A less radical operation often results in cure. In answer to the discussants, Dr. Scarborough said that he considered the operation to be indicated in every case of carcinoma of the rectum or rectosigmoid at any level and of any size, other than the small, pedunculated freely movable tumors.

In his paper *Valvular Drainage of Empyema by Means of a Skin Flap*, Leo Eloesser, San Francisco, Calif., described an operation by which a plastic skin flap or valve is made for the treatment of empyema. He pointed out that this flap operation, once done, requires no further care.

Frank S. Dolley, Los Angeles, Calif., reported, in discussion, that he had used the operation about twenty-five times and had found it of real value in certain

Primary Tumors of the Diaphragm, Joseph W. Gale and (by invitation) Stanley R. Edwards, Madison, Wis.—The occurrence of primary tumors of the diaphragm has been found to be extremely rare. Only twelve cases have been previously reported. Eight of these were malignant, four were benign. The methods of diagnosis, including artificial pneumothorax and pneumoperitoneum, with the description of their particular value in isolating the diaphragm from the surrounding structures, was discussed. The successful removal of a malignant tumor in the right hemidiaphragm was reported. This patient had remained free from recurrence for twelve months.

In the discussion **Thomas Kinsella, Minneapolis, Minn.**, reported the removal of a large benign tumor of the diaphragm. **Ethan F. Butler, Ithaca, N. Y.**, also reported the removal of a cyst of the diaphragm.

Removal of Teratoma From the Anterior Mediastinum, Stuart W. Harrington, Rochester, Minn. (movie).—The cinema dealt with the removal of tumors of the thorax and mediastinum. The author feels that the posterolateral incision and transpleural removal of anteriorly placed tumors is the operation of choice. The technique employed in the removal of intrapulmonary and mediastinal tumors also was demonstrated beautifully.

Pulmonary Ventilation and Anesthesia in Major Chest Surgery, Clarence Crafoord, Stockholm, Sweden (guest speaker).—The author gave a detailed discussion on the alterations in physiology occurring in the presence of an open pneumothorax mentioning in particular the difficulty of adequate oxygen exchange in these cases. He described the machine which he had developed with which it was possible to produce a rhythmic insufflation of the lungs in the presence of an open pneumothorax, which permitted an increased tidal volume while using nitrous oxide as an anesthetic agent. Nitrous oxide is preferred because of its lack of irritation to the respiratory system, the few tracheobronchial complications, the lack of shift of the mediastinum, the small amount of shock, and the adequate time allowed for meticulous care in performing the operation, particularly in closure of the bronchial stump following pneumonectomy.

Differential Pressure and Reduced Lung Function in Intrathoracic Operations, W. E. Adams, Chicago, Ill.—Experimental and clinical evidence was presented to demonstrate the hazards associated with some of the methods employed at the present time in maintaining differential pressure within the tracheobronchial tree. The relationship between high intrabronchial pressure and pneumothorax was discussed and demonstrated along with the resultant mediastinal emphysema which occurred in experimental animals with the use of a too high intrabronchial pressure.

Further Studies of Survival Following the Maintenance of Life During Experimental Occlusion of the Pulmonary Artery, John H. Gibbon, Jr., Philadelphia, Pa.—The author described the methods employed in animals whereby life could be maintained by clamping the pulmonary artery and stopping the flow of blood completely in the lungs, at the same time withdrawing blood from a peripheral vein, introducing oxygen into this media, and returning it as oxygenated blood to the animal's arterial system through a peripheral artery. The results of these experiments performed on cats were described. Animals which were deprived of their blood for thirteen minutes without the replacement of oxygenated blood showed advanced cerebral changes, while the animals in which the blood was removed, oxygenated, and replaced survived after eighteen minutes without evidence of cerebral changes.

THE TWENTY-SECOND ANNUAL MEETING OF THE
AMERICAN ASSOCIATION FOR THORACIC
SURGERY, JULY 5, 6, and 7, 1939*

JOSEPH W. GALE, M.D., MADISON, WIS.

THE twenty-second annual meeting of the American Association for Thoracic Surgery was held in Los Angeles, Calif., July 5, 6, and 7, 1939, with headquarters at the Ambassador Hotel.

The program committee succeeded in producing a most interesting group of papers which were in each instance original and very instructive.

The local committee on arrangements, consisting of J. J. Singer, Frank S. Dolley, and John C. Jones, provided most excellent entertainment and saw to it that all members of the association and guests were made to feel that the far West was glad to act as hosts to the organization.

Benign Chondroma of the Chest Wall, Fred R. Harper, Denver, Colo.—The author stated that these tumors are not rare, even though they have not been reported in large numbers. Approximately sixty cases were collected from the literature and two added in this paper. These tumors have a tendency to recur as a malignant tumor. They grow insidiously over a long period of time and are usually discovered accidentally. The origin is not clear, but they may appear from islands of fetal cartilagenous rests, postrachitic cartilagenous islands, or trauma. The treatment as given by the author consists in early complete removal of the tumor using the type of incision to fit the particular case.

Primary Tumors of the Ribs, Robert M. James, Toronto, Ontario.—The author added eight new cases of primary tumors of the ribs to the literature. The diagnosis and classification of these tumors as they appear in the literature is misleading. The necessity of a tumor registry was cited. He advised early and complete removal to prevent recurrences in the form of a malignant tumor. In the discussion the similarity between tumor of the rib and those of the intercostal nerves was brought out; also the mistake in diagnosis of such tumors, confusing them with inflammatory lesions occurring in the ribs in the form of a typhoid osteomyelitis. The surgical approach to these tumors was also discussed.

Pectus Excavatum, A. Lincoln Brown, San Francisco, Calif. (by invitation).—Seven cases were reported, all of which seemed to be on an hereditary basis. In the author's experience simple removal of the depressed sternum did not correct the deformity. The condition appears to be brought about by the activity of the diaphragm. This was demonstrated following the removal of the sternum by the presence of a dense substernal ligament. After division of this ligament there was marked separation and the deformity disappeared obviating the chances of recurrence. The operative procedure, which included section of the anterior attachments of the diaphragm to the gladiolus and with the substernal ligaments at the level of the junctions of the xiphoid and gladiolus, was described as particularly effective to arrest the development of the deformity of pectus excavatum in young children.

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*The articles abstracted here will appear in entirety in subsequent issues of the *Journal of Thoracic Surgery*.

the injection of air in certain instances might do away with the necessity of another stage of thoracoplasty in certain cases due to the ability of air to hold the lysed apex in a position which was gained at the time of operation.

Planography (Body Section Radiography) as Applied Especially to Pulmonary Disease, Warren C. Breidenbach, Dayton, Ohio (by invitation).—A description of the present methods of application and the advantages in spotting the location, depth, and size of cavities or new growths involving the lung were given.

Four Years' Experience With Extrapleural Pneumooleothorax, Oscar S. Proctor, Settle, Wash.—The author was probably the first in the United States to employ the use of extrapleural pneumothorax since his cases included a follow-up of four years. The technique of the procedure of extrapleural pneumothorax was again described. Oleothorax was used in these cases after all fluid had been aspirated from the extrapleural cavity and it was considered dry and clean and the desired collapse had been obtained. Some of these cases had been observed as long as four years. In the author's experience he found that only small refills of oil were necessary every six to twelve months once the oleothorax was properly established. No serious complications were encountered following the use of oil. No bronchial fistulas had developed allowing the oil to escape in the tracheobronchial tree. Olive oil with a 2 per cent gomenol was used in all cases. A small amount of oil was introduced first to determine the susceptibility of the patient to the oil. If no untoward reaction occurred, the extrapleural cavity was rapidly filled.

Presidential Address, Harold Brunn, San Francisco, Calif.—Two interesting pulmonary tumors were presented. These arose in the lung parenchyma. They carried several pathologic diagnoses and brought up the question which is vital to the clinician; namely, "what to do with such tumors when there is a disagreement as to the degree of malignancy present." In one instance the tumor was excised. In the second instance the author performed a lobectomy. He stated that had the nature of these tumors been better understood the treatment in the two tumors might have been absolutely reversed. Note was also made of the fact that the x-ray appearance of these tumors was identical. Furthermore, the author stated the necessity of a tumor registry whereby these tumors could be more closely studied and a follow-up of such cases be carried out for a sufficient length of time to give the clinician a criterion to go by as to the operative procedure to employ in the treatment of these tumors.

A Comparative Report on Infection of Thoracoplasty Wounds: Experience With the Ultraviolet Irradiation of the Operating Room Air, Richard H. Overholt and (by invitation) Reeve H. Betts, Boston, Mass.—The report concerned infection occurring in 411 cases of thoracoplasty done over a period of two and one-half years, following the use of ultraviolet irradiation checked by previous tests to determine its efficiency during and following voluntary air contamination. It was found to be highly bactericidal. The authors employed a light, placing two lights at the junction between the ceiling and wall of the operating room so that a cross-ray was thrown downward to the patient and into the wound. By keeping the light in this elevated position, there was less danger of burning the operating room personnel and less protection to the eyes and exposed skin surfaces was found to be necessary. In the group of cases reported following this new type of treatment and a new method of wound closure, the incidence of infection was reduced from 6.53 per cent to 0.48 per cent.

Hemicardiac Hypertrophy and Enlargement Solely Due to Increased Peripheral Resistance: A Study of Pulmonic and Aortic Stenosis Experimentally Produced, Emile Holman, San Francisco, Calif.—Small puppies ranging in age from ten days to six weeks were operated upon, the aorta and pulmonary artery being partially ligated just beyond the heart. The development of changes in the heart was followed by x-ray and necropsy studies with a comparison of the experimental animals and their hearts with their litter mates as controls. Arterial aortic stenosis produced a marked hypertrophy of the left ventricle as compared with controlled animals. Stenosis of the pulmonic artery produced a hypertrophy of the right ventricle. The control animals developed more rapidly than their litter mates. These results were compared with the dilatation that occurred in the presence of the arteriovenous fistula.

Factors Affecting the Regeneration of the Lung, Roy Cohn, San Francisco, Calif., (by invitation).—Different amounts of lung tissue were removed from rats. In all except old rats the original weight of the remaining lung tissue was restored within two weeks. The change in weight of the remaining lung tissue was dependent upon the size of the remaining thoracic cage. The effect of plombage, phrenic block, and high altitude on the weight of the lung was discussed. The heart weight was increased in all cases up to 40 per cent. No proof of cause of increase in weight was found. Alveolar counts showed no increase in the number, but the author thought the increase was very likely due to a thickening of the alveolar walls and an increase in the perivascular connective tissue.

A Selective Type of Thoracoplasty Operation, William A. Hudson, Detroit, Mich.—The author gave his experience of five years with a different type of thoracoplasty. The method included, first, the anterior removal of a greater part of the first two ribs, plus the lysis of the pleural attachment along the anterior mediastinum and vertebral gutter. This was followed by a second operation, at which time the posterior segments were removed through a paravertebral incision. The author states specifically that although the lysis was carried out around the apex, the tip of the apex was left suspended by the fibers of Sibson's fascia so that the collapsed lung assumed a narrow conical appearance in the chest.

The End Results of 511 Thoracoplasty Patients, E. J. O'Brien, Detroit, Mich.—The author stated his hope that thoracoplasty would be unnecessary in the future and that it may be successfully prevented by early adequate medical care. He also stated that every thoracoplasty patient was a challenge to medical treatment. The results of different types of thoracoplasty operations along with early and late mortality were discussed. The productive lesion cases showed early mortality in this series of 9 per cent plus, while the exudative cases showed a slightly higher mortality, 12 per cent. The cardiorespiratory reserve, the conversion of sputum, and the rehabilitation of these patients were given particular attention in the discussion.

Extrascapular Air as an Adjunct to Thoracoplasty With Extrascapular Apicolysis, T. B. Aycock and (by invitation) Otto C. Brantigan and Hugh Welch, Baltimore, Md.—Thirty-six cases of scapular apicolysis were reported in which air was introduced to fill the overlying dead space created by the apicolysis. This was preferred by the authors to fluid. Air refills were continued until the rib regenerated with sufficient stability to hold the apex in the collapse position. They felt that

the injection of air in certain instances might do away with the necessity of another stage of thoracoplasty in certain cases due to the ability of air to hold the lysed apex in a position which was gained at the time of operation.

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Polypoid Bronchial Tumors, H. Brodie Stephens and (by invitation) Alfred Goldman, San Francisco, Calif.—Three types of tumor were described: (1) endobronchial, (2) intramural, (3) endoextrabronchial. The distinguishing characteristics of bronchial adenomas on the one hand from the metastasizing carcinomatous polypoid tumors, as well as from the benign polypoid tumors endowed with the least growing potentialities, and the difficulties in making the diagnosis were given. This led to the very different decisions as to the type of procedure to follow in the removal of such tumors. Bronchiogenic removal was deemed ill advised in such cases where there was evidence of invasion into the peribronchial tissues. The discussion of lobectomy and pneumonectomy and the choice of either method could not be settled definitely until the pathologists could be brought to an agreement on the classification of these growths; namely, as to whether they were benign or malignant. Furthermore, the thoracic surgeon will have to have further experience to determine through follow-ups and final check of such patients before the correct method of treatment can be determined.

The Diagnosis and Surgical Therapy of Patent Ductus Arteriosus, John C. Jones, F. S. Dolley, and (by invitation) Lewis T. Bullock, Los Angeles, Calif.—Seven cases of patent ductus arteriosus operated upon were reported. A movie film was shown giving the detail of operative technique. Attention was drawn to the necessity of a correct diagnosis by pathognomonic signs and symptoms encountered in these cases. The danger of attempting the procedure in the presence of coarctation of the aorta and other congenital abnormalities was discussed along with the difficulties of the operative procedure once a correct diagnosis had been made.

Operations for Development of Collateral Circulation to the Heart, Peter Heinbecker and (by invitation) Wesley A. Barton, St. Louis, Mo.—An experimental study was made on sixty dogs upon which a pericardotomy was done. The pericardium once opened was desensitized with novocain, following which a solution of aleuronate plus 0.5 per cent sodium morrhuate was injected into the pericardial sac. The opening in the sac was then closed and it was sutured to the retrosternal structures. Observations made on these animals three and sixteen weeks later showed the presence of fibrous adhesions between the heart and pericardial wall. These adhesions were injected by a special technique which showed definitely that they contained new blood vessels. This was thought by the author to be applicable to clinical surgery.

Dorsal Sympathetic Ganglionectomy for Intractable Asthma, Duane Carr, Memphis, Tenn.—The author gave a brief résumé of the voluminous literature on this subject, mentioning the points of disagreement regarding the disease. He also reported three patients upon whom he had done a bilateral resection of the third and fourth dorsal sympathetic ganglia. Favorable results were obtained in two of these cases. The third was apparently unsuccessful because the "trigger area" does not always lie in the bronchial mucosa. His description of the technique of exposing the sympathetic ganglia by the extrapleural approach was given and its advantages over other approaches. These operations were performed under local anesthesia without any undue discomfort to the patient.

Large Infected Pulmonary Cysts Simulating Empyema, Herman C. Maier, New York, N. Y., and Cameron Haight, Ann Arbor, Mich.—The authors stated that the mistake in diagnosis of large infected pulmonary cysts was not infrequent and that they were often treated as encapsulated empyema rather than as cysts. A close study of the type of secretion obtained from these cavities at the time

of operation, the persistence of the cavity, and the lack of such clinical manifestations as high fever and signs of chronic pulmonary suppuration should lead one's curiosity to be aroused to such an extent as to become suspicious of the presence of such cysts. The two groups of cysts which occur most commonly were demonstrated; namely, those lined with epithelium and those without; also the congenital and acquired types. In the treatment the author stated that collapse procedures were contraindicated, simple drainage procedures would not correct the condition, but the only satisfactory method was removal of the cyst lining.

Acute Putrid Abscess of the Lung, Harold Neuhof and Arthur Touroff, New York, N. Y.—The authors reported eighty-four cases of acute putrid lung abscess, stating the indications for operation, the type of operation to be employed, and the operative results. Three deaths occurred in this group of patients. The authors feel that early operation is to be preferred, preferably a one-stage procedure if possible.

Joint Manifestations Associated With Lung Tumor, Willard Van Hazel, Chicago, Ill.—The author reported seven cases. Five were malignant and two were benign. All of these patients were without lung symptoms. In each case there was a hypertrophic pulmonary osteoarthropathy accompanied by great disability. In two of these cases there was a complete disappearance of symptoms following pneumonectomy for bronchiogenic carcinoma. In one instance the removal of a large intrathoracic fibroma resulted in the abatement of symptoms.

Book Reviews

Varicose Veins. By Alton Ochsner, M.D., and Howard Mahorner, M.D. Cloth. Pp. 147, with 50 illustrations and 2 color plates. St. Louis, 1939, The C. V. Mosby Company. \$3.

In this excellent monograph the authors have covered in a comprehensive manner the subject of varicosities of the lower extremities. The various aspects of the subject, such as history of treatment, anatomy, pathology, physiology, etc., are presented in separate chapters. For this reason the book is well suited to serve as a reference book for both the student and practitioner.

In the chapter entitled "Examination of the Varicose Vein Patient," the various tests and methods of examination are critically discussed from the standpoint of anatomy and physiology. The comparative tourniquet test, which is the contribution of the authors, is carefully described and the value of this test in the treatment of varicose veins is indicated.

The chapter on treatment is particularly worth while. The authors have drawn widely on their own wide clinical and experimental observations. The views they express are conservative, well founded, and orthodox.

There is little that one can criticize. Illustrations, both photographs and diagrams, are ample and well chosen. Much of the material presented has been published previously in the various surgical journals, but this fact in no way detracts from the value of the present publication. Since a short chapter on the treatment of varicose ulcers has been included, one wonders if this portion of the work might not have been expanded with profit beyond its allotted three pages. An excellent bibliography and index are appended.

Praktische Anatomie. By T. von Lanz, Professor of Anatomy, University of Munich, and W. Wachsmuth, Instructor in Surgery, University of Bonn. Vol. I, Part 3. Cloth. Pp. 276, with 208 illustrations largely in color. Berlin, 1935, Julius Springer. R.M. 29. Vol. I, Part 4. Bein und Statik. Pp. 485, with 342 illustrations, largely in color. Berlin, 1938, Julius Springer. R.M. 29.

These extraordinary tomes by Lanz, Assistant Professor of Anatomy at Munich, and Wachsmuth, Instructor in Surgery at Bonn, are without question two of the finest volumes on practical gross anatomy that have ever been published. In their preface to the first volume the authors set themselves the "task of composing a work in anatomy that will bring honor to German medicine from the entire world." If the volumes to follow preserve the high standard set by these two, the objectives of the authors will not miss their mark.

For sheer beauty of artistic reproduction of dissections, the volumes are alone remarkable. Pictures that are a real pleasure for the eye to gaze upon and study occupy almost every page of each volume. There are illustrations in color of large regional dissections, cross sections, and surgical approaches and exposures. It seems most unusual that the authors failed to mention the names of the artists whose work contributed so much to the success of this enterprise.

To be sure, the illustrations constitute the most illuminating portion of these volumes. Yet, the general plan of the book in itself is excellent. An intimate collaboration of anatomist and surgeon has resulted in volumes which will appeal particularly to surgeons. A special feature is the listing of the frequency of anomalies. Developmental osseous anatomy also receives consideration. A particular feature of the second volume is the graphic reproduction of the range of joint motion with the apposed members in various positions. Well-selected bibliographic references accompany each volume.

Surgeons who delight in holding fine books in their hands and thrill at the sight of beautiful illustrations will hasten to add these volumes to their library. Those responsible for the teaching of applied anatomy in medical schools will find the volumes useful.

Textbook of Healthful Living. By Harold S. Diehl, M.D., Dean of Medical Sciences, University of Minnesota Medical School, Minneapolis. Cloth. Ed. 2. Pp. 634, with 63 illustrations. New York, 1939, McGraw-Hill Book Company. \$2.50.

This is a revised and enlarged edition of a book that has already earned very deserved recognition, both as a class text on personal hygiene and as a popular volume for the adult lay reader who seeks authentic information on health. The author has made a conscious effort to present a conservative point of view, being cautious to avoid creating false hopes and reserved in his estimates as to the possible attainments from various procedures for health maintenance. He assumes that his reader wants to know the truth rather than to be deceived by extravagant promises. In this respect the book offers a refreshing contrast from certain of the popular health "literature." Fads have been treated sympathetically yet without sacrifice of critical analysis; frauds have been mercilessly and frankly exposed. The author has enriched the text by an almost lavish use of reference material and quotations. In addition to being a most readable text, the volume contains a surprising amount of factual data which make it of added value as a reference book for the student of personal hygiene. The new edition has been enlarged by the addition of chapters on parenthood and community organizations for the protection of public health. This book can be highly recommended to anyone who seeks a sane and tempered discussion of healthful living.

The Circulation of the Brain and Spinal Cord (A Symposium on Blood Supply). By Editorial Board: Stanley Cobb, M.D., Angus M. Frantz, M.D., Wilder Penfield, M.D., and Henry A. Riley, M.D. Cloth. Pp. 313, with 120 illustrations. Baltimore, 1939, Williams and Wilkins Company. \$10.

This book contains the Proceedings of the 1937 Meeting of the Association for Research in Nervous and Mental Diseases. It is the eighteenth volume of such proceedings which have been published annually since 1920, each meeting having been devoted to a symposium on some phase of nervous and mental disease. The contributors to each volume are from laboratories and clinics which have been conducting researches on the subject under discussion. The current issue contains thirty-six chapters, or individual papers, by thirty-six different authors. These are grouped according to subject in the following sections: I. Anatomy and Physiology; II. Pathology; III. Clinical Contributions. In the final chapter

Cobb summarizes and discusses the most important recent advances in cerebral circulation. This chapter by Cobb will be read with much profit by anyone interested in nervous and mental diseases. The rest of the book is of value mostly as a reference work and is an indispensable reference for those engaged in research pertaining to circulation of the brain and spinal cord. Each chapter is accompanied by a bibliography. Most of these bibliographies are of good form and very extensive. There are many well-reproduced illustrations and a twenty-eight-page index.

This volume is indispensable for reference libraries.

Pathologische Physiologie Chirurgischer Erkrankungen (Experimentelle Chirurgie). By Franz Rost, M.D. (Deceased), and Th. Naegeli, M.D., University of Bonn, Germany. Paper. Ed. 1. Pp. 375, with no illustrations. Berlin, 1938, Julius Springer. R.M. 31.50.

Franz Rost's pathologic physiology of surgical diseases became well known to American students of surgery through the translation by Stanley Reimann of Philadelphia. More than a decade has elapsed since the publication of the third edition of the late Professor Rost's work upon which that translation was based. It is timely that a revision of this splendid source book be undertaken, and it is most gratifying to find that a portion of the new fourth edition is already in print. An enlarged edition of Rost's work is to appear under the editorship of Naegeli, of Bonn. In this undertaking he is to have as collaborators Kessel, Merke, and Meythaler, well-known German and Swiss surgeons.

The first volume concerning the alimentary canal and its appendages appears herewith. Naegeli has written most of the chapters. Those on the pancreas, liver, and biliary passages are written by Meythaler.

Though most of the references and discussions relate to work of German authors; nevertheless, the book is, as were earlier editions of Rost's work, one of the most valuable source books extant on the subjects under discussion. In a few instances the discussions are somewhat sketchy, but in the main all are very well done. Any surgeon can read the sections on ulcer, bowel obstruction, the liver, biliary passages, and pancreas with much profit. This volume should find favor with surgeons everywhere. It is a scholarly piece of work and constitutes the best available single reference book on the physiologic pathology of surgical diseases of the digestive tract. It is to be hoped that a translation will be made generally available for English-speaking surgeons.

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ANATOMY OF THE INGUINAL REGION

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IT IS probable that no teacher of gross anatomy is satisfied with the manner in which textbooks present the details of structures concerned with the inguinal region. The region, however, is receiving an increasing amount of attention, and particular points have been discussed in recent years by several investigators. None of these authors, however, consider the comparative anatomy or the stresses involved.

Concerned with the anatomy of the inguinal region are the lateral abdominal musculature and adjacent fasciae, both external (Scarpa's) and internal (transversalis) sheets, together with the derivatives and continuations of these, including inguinal ligament, reflex and lacunar ligaments, conjoined tendon and falx, and fascia lata; and sheath of the rectus, including the linea semicircularis. Some of these details, as the reflex and lacunar ligaments, are well understood, but in others the relationships are complex, the fasciae very variable, and the moot points to a considerable extent involve details that are not primary but have been secondarily developed in man by stresses that are difficult to interpret. Some of the features can be demonstrated only on young, vigorous bodies that are neither emaciated nor fat; to interpret the conditions, it is necessary to have recourse both to embryology and comparative anatomy.

In the following pages are reported the results of investigations of the most controversial details in regard to this region. After listing each detail, I have summarized very briefly the statements regarding it as expressed by the four textbooks and one atlas most frequently used by regular students of anatomy.

In the textbooks there is frequent reference to fusion of abdominal layers. The structures of the abdominal wall are developed from a single mass of mesoderm, which splits in various ways into muscular,

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aponeurotic, or fascial layers, so that the parts that we usually consider as fused really have remained undivided. Thus, the sheath of the rectus is not formed by the fusion of the aponeuroses of the lateral abdominal musculature, but is made of toughened fascia upon which the lateral aponeuroses insert.

The splitting of the lateral abdominal musculature into three layers is probably not fundamental. Together they are a condensation into muscle of the mesoderm that terminates ventrally in the rectus abdominis primordium. The latter develops a fascial envelope of its own. In some reptiles and amphibians there are four layers of lateral musculature, and transverse sections of some human embryos show a partial splitting of the external oblique into two layers. Just after these layers become defined in the embryo, there is rather clear indication that the external oblique constitutes one basic stratum and the internal oblique and transversus abdominis together, a second stratum. Comparative anatomy also suggests the fundamental separation of the abdominal musculature into two primary strata.

In the superior part of the abdomen the three abdominal layers behave as is described customarily for the adult: the external oblique, or its aponeurosis, passes to the superficial surface of the rectus; the transversus abdominis, to the deep surface; while the internal oblique splits to straddle the rectus. These layers thus insert upon the sheath of the rectus.

In the inferior part of the abdomen, however, the condition is different. The external oblique still passes superficial to the rectus, but the other two layers cease at the lateral border of the fascial envelope of the rectus. Thus, it is indicated that these two layers do not continue superficial to the rectus, and that the sheath of the rectus at this point is not formed by the fused aponeuroses of all three layers; but rather that the internal oblique and transversus abdominis are inserted upon the lateral part of the sheath of the rectus.

Experience has showed that it is not possible to dissect the inguinal region of a number of the lower mammals and thereby acquire a perfect chronological picture of the details, with regular transition from the lower to the higher forms. Doubtless the reason for this fact is that the items involved are largely the results of particular stresses and that these vary from one sort of mammal to another. The same set of conditions appears hardly to be duplicated in any but very closely related groups. Thus, the situation in a squirrel is quite different from that in a rat or in a rabbit. It is possible, however, by dissecting a number of mammals, to gain reasonable opinions regarding the basic conditions. The following statements embody the beliefs that these dissections have caused me to adopt.

As previously stated, there is strong evidence that fundamentally the external oblique comprises one layer that inserts upon the ventral sheath

of the rectus, and the internal oblique and transversus abdominis together constitute another. At times this compound layer reaches the rectus in the superior abdomen in an undivided condition. At other times, it does divide, and the internal oblique may split to straddle the lateral margin of the rectus sheath (man); while still again (beaver), the transversus abdominis is the layer that straddles the rectus border. So the straddling of the rectus border by the internal oblique, as in man, is not in itself a fundamental condition.

In most pronograde mammals, at least, the sharp angle of medial thigh with abdomen in the posture habitually adopted predisposes to some sort of strengthening inguinal band. This is also true of orthograde mammals of considerable weight, because of other stresses. Whether for these hypothetical reasons or some other, in at least some small, subadult male monkeys (*Macacus*), no definable inguinal band is present. In them there were two fascial layers crossing the inguinal line, one continued from the external oblique and the other from the internal oblique and transversus abdominis together. The two were easily separable with the probe and continued down the medial thigh as the homologue of a fascia lata, but were quite delicate. Beneath them the transversalis fascia also continued, but to form the subinguinal portions of the iliopsoas and femoral sheaths. It is believed that in these monkeys the transversalis fascia did not contribute to the fascia lata, but of this I could not be certain because of the delicacy of the tissue. However, there was very tender anchorage of the deeper layer, and hence probably of the transversalis fascia, to the innominate between the iliopsoas and femoral sheaths. In some other mammals (as the cat) the internal layer (internal oblique and transversus abdominis) appeared to fuse in the subinguinal region with the transversalis fascia to form the iliopsoas and femoral sheaths. In rodents there appears to be a tendency for the two basic abdominal layers to form two separable, strengthened inguinal arches, ligamentous in nature, arching over iliopsoas and femoral vessels, but with some delicate attachment to the innominate between.

Parts of the tela subcutanea of interest in the present connection are the fasciae of Scarpa, Colles, superficial fascia of the penis, tunica dartos of the scrotum, and fascia lata.

Scarpa's fascia, as textbooks agree, is the membranous deeper part of the tela subcutanea in the lower abdomen. It is of variable definition, however, and need not be the deepest part of the superficial fascia, for not infrequently there is considerable fat deep to it. Furthermore, in selected individuals it may occur in more than one layer, as may any fascia of considerable strength. It is anchored to the midline and contributes to the inguinal ligament, where it is fused to underlying tissue, as well as to the fascia lata, and continues onto the perineum as Colles' fascia.

Colles' fascia is said by the textbooks to be a direct continuation onto the perineum of Scarpa's fascia, anchored to the inferior ramus of the pubis and to the free border of the trigonum urogenitale, not continuing into the ischiorectal fossa. Gallaudet (1931) and Anson and McVay (1938) have stated that it does so continue, and furthermore, that deep to it is the inferior perineal fascia, a continuation upon the perineum of the innominate fascia of Gallaudet (fascia of the obliquus externus abdominis). The fasciae of the perineum, exclusive of the tela adiposa, perhaps consist fundamentally of three layers: (a) a continuation into this region of Scarpa's fascia (Colles' fascia); (b) the fascial continuation of the external oblique layer, which, upon the spermatic cord, becomes the external spermatic fascia; and (c) the fascial continuation of the internal oblique and transversus abdominis together, which, upon the spermatic cord, becomes the cremasteric fascia. The facility with which these three layers of fasciae may be detected is individually very variable and is difficult at best. The important point is that all three layers are theoretically present and all three act together as a unit in directing the course of extravasated fluid beneath them.

Superficial Fascia of the Penis.—This is confusingly treated by textbooks. At times it is called fascia penis, while again the latter term is applied to the deep fascia of the penis, and sometimes it is stated to be a continuation of Scarpa's fascia alone. In selected individuals, at least, it can be demonstrated that it represents the entire tela subcutanea, which in this situation is devoid of fat. Whether it may be considered as including also fasciae from the abdominal muscle layers remains to be demonstrated. An alternate term that is permissible is tunica dartos of the penis.

Tunica Dartos of the Scrotum.—This represents a continuation onto the scrotum of (a) the tela adiposa, but here usually devoid of fat; (b) Scarpa's and Colles' fasciae; (c) the external oblique fascia; and (d) the fascia of the internal oblique and transversus abdominis together, the four usually being inextricably blended. It is probable, although as yet unproved to my satisfaction, that *a* and *b* together line the scrotal sac, and that *c* and *d* provide separate pockets for the individual testes, thus forming the septum of the scrotum.

Fascia lata is a compound sheet formed by the fusion in various degrees of the continuations of Scarpa's fascia, external oblique fascia, and the fascia from internal oblique and transversus together, to a minor extent the transversalis fascia by means of its continuing iliopsoas fascia, and in particular instances at least, it comprises contribution from the deep fascia of the thigh muscles. It encloses the tensor fasciae latae and sartorius muscles and frequently may be separated into irregular layers.

Buck's fascia, or the deep fascia of the penis, is treated very unsatisfactorily by the textbooks and, if described at all, is usually stated to be

a continuation of Scarpa's or Colles' fasciae. It is the tough, dense covering of the three corpora cavernosa and is a purely local development.

Sheath of the Rectus.—Regularly the sheath of the rectus is regarded as formed by fusion of the aponeuroses of the abdominal muscles, and as complete, dorsally and ventrally, only as far as the linea semicircularis, inferior to which the dorsal part of the sheath is lacking. The sheath of the rectus, however, is what its name implies. Upon it the aponeuroses of the abdominal muscles insert, and it is complete inferiorly as well as superiorly, although it differs in strength locally. The sheath has three portions: a costal part, suspended chiefly between the inferior margins of the thorax; a mesogastric part; and a hypogastric or interiliac part. In the costal part the sheath is anchored to bone, or cartilage, along both margins, and both dorsal and ventral parts are strong. The latter is also the case in the mesogastric part, because the abdominal muscles insert upon both the dorsal and ventral surfaces of the sheath. In the hypogastric part, however, the abdominal muscles do not insert upon the dorsal sheath, which here is much weaker, all strengthening tissue passing between the two ilia (and inguinal ligaments) upon the ventral surface of the sheath.

Linea Semicircularis.—The semicircular line is regularly described as the inferior termination of the dorsal part of the sheath of the rectus, where the aponeurosis of the transversus abdominis and half that of the internal oblique abruptly shift to the ventral surface of the sheath; while below this line, the rectus is covered dorsally only by the fascia transversalis. The linea semicircularis is merely a strengthened band of connective tissue that stretches in a curved line from the linea alba toward the lateral end of the inguinal ligament. Its position, when present, is variable. Chouke (1935) said that it may be found anywhere from 0.25 to 4.25 inches inferior to the umbilicus. The situation, however, appears usually to be about 2 inches below the umbilicus. Often the semicircular line cannot be detected, and very frequently indeed it is definable only after careful work with the probe. Occasionally two dim lineae semicirculares are faintly suggested, one inferior to the other. Solger (1931) stated that this accessory line is most frequently present in heavy workers and in multiparas.

The linea semicircularis merely marks the abrupt change in toughness of the dorsal sheath of the rectus, and the connective tissue layer always stretches inferiorly from the linea as an uninterrupted and unbroken, although often exceedingly thin, sheet of fascia. In cases in which the linea is not well defined there is merely a gradual diminution inferiorly in the strength of the deep sheath of the rectus, and in many instances, even this weakening is not pronounced. Hence it is believed, as indeed Solger suggested, that the change in the character of the dorsal or deep sheath of the rectus at the linea semicircularis, where this occurs, is in-

Colles' fascia is said by the textbooks to be a direct continuation onto the perineum of Scarpa's fascia, anchored to the inferior ramus of the pubis and to the free border of the trigonum urogenitale, not continuing into the ischiorectal fossa. Gallaudet (1931) and Anson and McVay (1938) have stated that it does so continue, and furthermore, that deep to it is the inferior perineal fascia, a continuation upon the perineum of the innominate fascia of Gallaudet (fascia of the obliquus externus abdominis). The fasciae of the perineum, exclusive of the tela adiposa, perhaps consist fundamentally of three layers: (a) a continuation into this region of Scarpa's fascia (*Colles' fascia*); (b) the fascial continuation of the external oblique layer, which, upon the spermatic cord, becomes the external spermatic fascia; and (c) the fascial continuation of the internal oblique and transversus abdominis together, which, upon the spermatic cord, becomes the cremasteric fascia. The facility with which these three layers of fasciae may be detected is individually very variable and is difficult at best. The important point is that all three layers are theoretically present and all three act together as a unit in directing the course of extravasated fluid beneath them.

Superficial Fascia of the Penis.—This is confusingly treated by textbooks. At times it is called fascia penis, while again the latter term is applied to the deep fascia of the penis, and sometimes it is stated to be a continuation of Scarpa's fascia alone. In selected individuals, at least, it can be demonstrated that it represents the entire tela subcutanea, which in this situation is devoid of fat. Whether it may be considered as including also fasciae from the abdominal muscle layers remains to be demonstrated. An alternate term that is permissible is tunica dartos of the penis.

Tunica Dartos of the Scrotum.—This represents a continuation onto the scrotum of (a) the tela adiposa, but here usually devoid of fat; (b) Scarpa's and Colles' fasciae; (c) the external oblique fascia; and (d) the fascia of the internal oblique and transversus abdominis together, the four usually being inextricably blended. It is probable, although as yet unproved to my satisfaction, that *a* and *b* together line the scrotal sac, and that *c* and *d* provide separate pockets for the individual testes, thus forming the septum of the scrotum.

Fascia lata is a compound sheet formed by the fusion in various degrees of the continuations of Scarpa's fascia, external oblique fascia, and the fascia from internal oblique and transversus together, to a minor extent the transversalis fascia by means of its continuing iliopsoas fascia, and in particular instances at least, it comprises contribution from the deep fascia of the thigh muscles. It encloses the tensor fasciae latae and sartorius muscles and frequently may be separated into irregular layers.

Buck's fascia, or the deep fascia of the penis, is treated very unsatisfactorily by the textbooks and, if described at all, is usually stated to be

the falx, and from this arch the cremasteric fascia continues down the cord. When weakly developed, the arch is difficult to define.

Perhaps every teacher of gross anatomy has frequently noted divergent muscle slips of the internal oblique in the vicinity of the ilium. Chouke (1935), calling them the accessory internal oblique, appears to have been the first to indicate that these slips are of fairly regular form and usual occurrence. He described the accessory muscle as between the internal oblique and transversus abdominis (Figs. 1 and 2), and as present on both sides in 85 out of 136 cadavers, questionably so in 12 more, and on one side of all except 4 of the remainder. Certainly it is not detectable as a separate slip in such a large proportion of the cadavers (more than half of them negroes) used at Johns Hopkins University, nor does it occur always internal to the main part of the internal oblique.

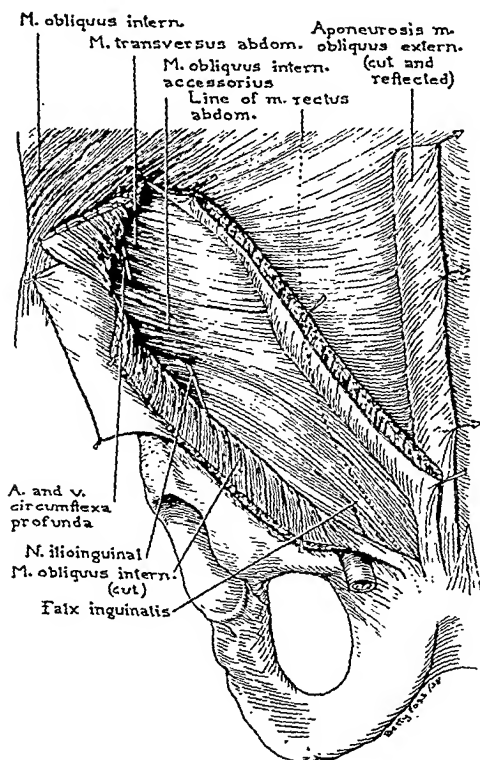


Fig. 1.—Obliquus externus completely reflected and obliquus internus partially reflected to show position of the obliquus internus accessorius muscle.

The fact of chief significance is that in man there is an added stress in this region, as is indicated by a thickening of the part of the internal oblique arising from the anterior spines of the ilium and the lateral part of the inguinal ligament; hence, at the point of interiliac stress through the linea semicircularis. At its maximum this results in a separable slip of muscle, between 1 and 2 inches wide, usually upon the internal, but at times upon the external, surface of the internal oblique. When in the

duced by particular interiliac stresses and a diminution, or at least change in character, of those stresses inferior to the linea.

Lateral Abdominal Muscles.—All three layers of abdominal muscles insert upon the sheath of the rectus, and all three blend with the inguinal ligament for its entire length. From one viewpoint the obliquus externus abdominis may be thought of as a fundamental layer composed of muscle, aponeurosis, and fascia. The aponeurosis is attached medially to the sheath of the rectus and to the pubis. Inferolaterally the aponeurosis increases in toughness in a line between the ilium and pubis (inguinal ligament), where it is fused with the layers next superficial and deep, and more inferiorly contributes to the formation of the fascia lata. The aponeurosis splits to form the external inguinal ring. Just as this layer contributes to the fascia lata, so does its fascia continue along the spermatic cord as the external spermatic fascia, upon the perineum deep to Colles' fascia, and undoubtedly upon penis and scrotum as indistinguishable deeper parts of the tunica dartos of these regions. This fascial continuation from the external oblique has been regarded by Gallaudet (1931) and Anson and McVay (1938) as a fascia (innominate fascia) which in the pubic region occurs between Scarpa's fascia and the deep fascia of the external oblique muscle. Actually it definitely appears to be the latter.

Frequently in the inferior abdomen and not infrequently in the mesogastric region, obliquus internus and transversus abdominis remain undivided for some distance lateral to the sheath of the rectus, and this undivided part constitutes the conjoined tendon. The two layers together contribute cremasteric fascia and cremaster muscle to the spermatic cord, although in most cadavers the cremaster receives muscle fibers from the internal oblique only. This inner fundamental layer also contributes to the fascia lata and apparently to the deeper parts of the fascia of the perineum and of the tunica dartos of penis and scrotum as well, although the continuity is difficult to follow.

In the superior part of the abdomen of man, the aponeurosis of the internal oblique usually splits to straddle the rectus sheath, but often this is not detectable in the umbilical region. Inferiorly the insertion is definitely upon the ventral sheath of the rectus in those cases in which there is no conjoined tendon or when the muscle fibers extend farther medially than the border of the rectus. The thickest part of the muscle is adjacent to the ilium, while inferior to that level it becomes weaker. Muscle fibers arise usually from the lateral part of the inguinal ligament only, but more medially there is fascial attachment to the inguinal ligament; or more properly speaking, this layer contributes a fascia to the formation of the ligament. When strongly developed and when separable at this point from the transversus abdominis (i.e., in the absence of a conjoined tendon), this part of the internal oblique forms above the spermatic cord an aponeurotic arch, the medial part of which constitutes

former situation it is separated from the internal oblique by branches of iliohypogastric nerve and of the deep circumflex vessels. One may clearly see that the tension of this accessory slip is in a line that curves toward the symphysis, ending not at the midline but at the lateral margin of the origin of rectus abdominis muscle. It seems not unlikely that this muscle, or the stress that produced it, is an exclusively human feature in process of development, because of the erect posture, for strengthening the lower abdominal wall. It is interesting to note that its inferior border lies directly superior to the area of the weak spot of Hesselbach's triangle. It and the linea semicircularis provide two crossed, strengthening bands as shown in Fig. 2.

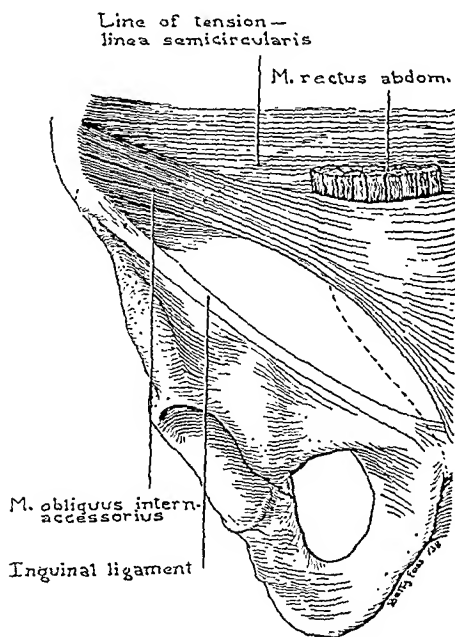


Fig. 2.—The obliquus internus accessorius muscle, showing its line of tension in respect to the indicated line of tension through the linea semicircularis. Overlying structures have been removed.

Superiorly the aponeurosis of the transversus abdominis inserts upon the deep sheath of the rectus, but inferiorly upon its lateral border when conjoined tendon is absent. Near the inguinal ligament the transversus abdominis resembles the internal oblique, with muscle fibers arising from the lateral part of the ligament, with fascial attachment to the ligament for its entire length. But when the conjoined tendon is absent the part of the transversus abdominis arching over the cord is usually weaker than the falx and more closely adjoins the cord. It is the theoretically aponeurotic part of this layer medially adjacent to the spermatic cord that in reality forms the interfoveolar ligament, although in some cases the transversalis fascia contributes to it.

Conjoined Tendon.—Textbooks usually define this as the inferior part of the fused aponeuroses of internal oblique and transversus abdominis,

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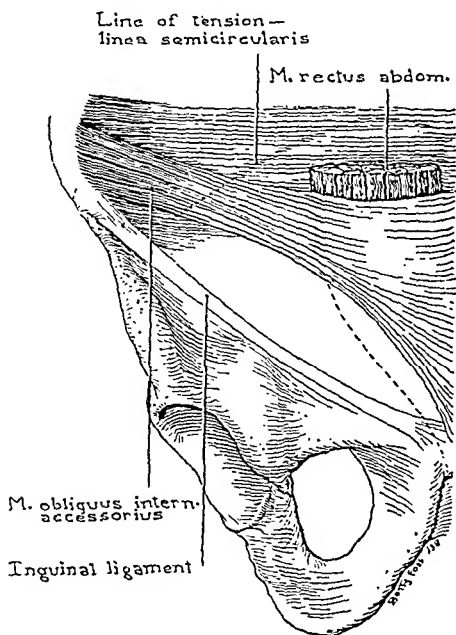


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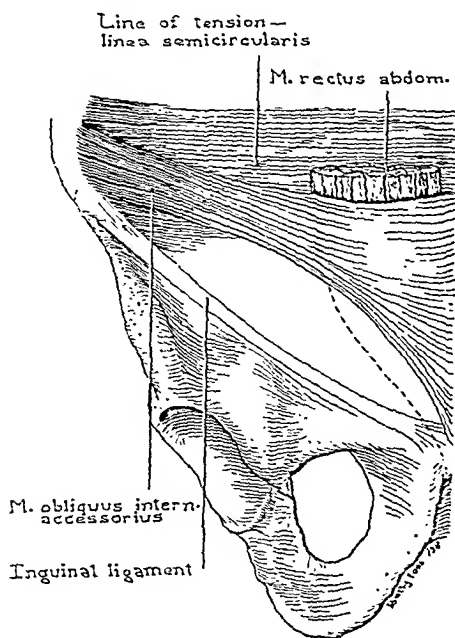


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linea alba, thus forming the reflex ligament in whole or in part; and others curve dorsally to form the lacunar, or Gimbernat's, ligament upon the medial wall of the femoral ring. The reflected part is variable, with fibers sometimes stopping on the pubis, or again continuing superomedially quite to the linea alba and decussating with fibers of the opposite side of the body; but it is almost always present to some degree. To this structure the fibers of the inferior crus of the external inguinal ring contribute in varying amount.

Transversalis Fascia.—There is considerable variation in the textbook definition of this fascia, the implication often being that it is a single layer of fascia between transversus abdominis muscle and the peritoneum. Anson and McVay considered it to be the deep fascia of the transversus abdominis muscle, but this is quite different. There appears to be but little question that the term transversalis fascia should be applied to all connective tissue between the deep fascia of the transversus abdominis muscle and the peritoneum. It thus bears the same relation internally between muscles and peritoneum as the tela subcutanea does externally between muscles and skin. It varies locally in its definition and in the number of layers into which it may be divided. At some spots it fuses with the deep fascia of the transversus abdominis, iliacus, or other internal musculature, and at others merges with the fibrous layer of the peritoneum. The term transversalis fascia is regularly applied to the connective tissue between the rectus abdominis muscle, inferior to the linea semicircularis, and the peritoneum. But the tissue in this situation consists both of a thin sheet of rectus sheath and transversalis fascia, the latter not infrequently separable into more than one distinct layer.

Upon careful examination it is seen that the transversalis fascia tends to increase in thickness in the neighborhood of the spermatic cord. Fibers from its more superficial surface follow down the cord to become the internal spermatic fascia; but fibers of its deeper surface also follow up the cord. Its fibers merge as well with the fascia covering iliacus and psoas muscles and other structures, and these coverings are merely part of the transversalis fascia. The part investing the iliopsoas continues over these muscles beneath the inguinal ligament, partly fused with the ligament there, becoming the iliopectineal fascia, and more inferiorly partly fused with the fascia lata. The transversalis fascia also contributes to the sheath of the femoral vessels.

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THE ACTIVITY OF ISOLATED SEGMENTS OF THE COLON OF DOGS, WITH SPECIAL REFERENCE TO THE INFLUENCE OF CERTAIN DRUGS

ROBERT E. REAGAN, M.D., BENTON HARBOR, MICH., AND
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PRIOR to 1900 considerable study of the motility of the small intestine was made, but very little investigative work was done on the colon. Since then, many excellent studies of the colon have revealed much information about its normal motility. However, in most experiments the animals were either anesthetized or balloons were placed in the lumen of the bowel. Thus, the animals were studied under abnormal physiologic conditions or the bowel was subjected to mechanical irritation.

To overcome these objections, isolated segments of the colon were transplanted to the abdominal wall where they could be observed under all conditions over long periods of time without the use of anesthesia or mechanical irritation. The dogs were prepared by isolating segments from the upper, middle, and lower colon. Studies were directed toward the determination of normal movements of the dog's colon in the fasting state and after feeding and the effect of the following drugs upon these movements: pitressin, morphine sulfate, atropine sulfate, prostigmin, 0.85 per cent sodium chloride, 20 per cent sodium chloride, and 50 per cent glucose.

Magnus¹¹ and later Alvarez¹ made valuable observations of intestinal motility by taking full-thickness strips from various parts of the intestinal tract and immersing them in Locke's solution. The solution was kept at a constant temperature and was oxygenated. The rate of contraction of the immersed strips was noted. Numerous drugs were added to the solution and the effect on the rate of contraction recorded. Alvarez found that the average rate of contraction of the duodenum was 15.3 per minute; of the jejunum, 13.3; of the upper ileum, 10.5; and of the colon, 6.8 per minute. From these observations he developed his gradient theory of intestinal motility.

Jacobj,⁸ in 1890, was the first to report antiperistaltic movements and these observations were confirmed by Cannon⁵ in 1901. Fluoroscopic observations were carried out on the cat following a barium meal. Cannon states that antiperistaltic waves set in soon after food enters the colon and continue for periods of two to eight minutes at a rate of five waves per minute. After these have been occurring for some time,

linea alba, thus forming the reflex ligament in whole or in part; and others curve dorsally to form the lacunar, or Gimbernat's, ligament upon the medial wall of the femoral ring. The reflected part is variable, with fibers sometimes stopping on the pubis, or again continuing superomedially quite to the linea alba and decussating with fibers of the opposite side of the body; but it is almost always present to some degree. To this structure the fibers of the inferior crus of the external inguinal ring contribute in varying amount.

Transversalis Fascia.—There is considerable variation in the textbook definition of this fascia, the implication often being that it is a single layer of fascia between transversus abdominis muscle and the peritoneum. Anson and McVay considered it to be the deep fascia of the transversus abdominis muscle, but this is quite different. There appears to be but little question that the term transversalis fascia should be applied to all connective tissue between the deep fascia of the transversus abdominis muscle and the peritoneum. It thus bears the same relation internally between muscles and peritoneum as the tela subcutanea does externally between muscles and skin. It varies locally in its definition and in the number of layers into which it may be divided. At some spots it fuses with the deep fascia of the transversus abdominis, iliacus, or other internal musculature, and at others merges with the fibrous layer of the peritoneum. The term transversalis fascia is regularly applied to the connective tissue between the rectus abdominis muscle, inferior to the linea semicircularis, and the peritoneum. But the tissue in this situation consists both of a thin sheet of rectus sheath and transversalis fascia, the latter not infrequently separable into more than one distinct layer.

Upon careful examination it is seen that the transversalis fascia tends to increase in thickness in the neighborhood of the spermatic cord. Fibers from its more superficial surface follow down the cord to become the internal spermatic fascia; but fibers of its deeper surface also follow up the cord. Its fibers merge as well with the fascia covering iliacus and psoas muscles and other structures, and these coverings are merely part of the transversalis fascia. The part investing the iliopsoas continues over these muscles beneath the inguinal ligament, partly fused with the ligament there, becoming the iliopectineal fascia, and more inferiorly partly fused with the fascia lata. The transversalis fascia also contributes to the sheath of the femoral vessels.

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THE ACTIVITY OF ISOLATED SEGMENTS OF THE COLON OF DOGS, WITH SPECIAL REFERENCE TO THE INFLUENCE OF CERTAIN DRUGS

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PRIOR to 1900 considerable study of the motility of the small intestine was made, but very little investigative work was done on the colon. Since then, many excellent studies of the colon have revealed much information about its normal motility. However, in most experiments the animals were either anesthetized or balloons were placed in the lumen of the bowel. Thus, the animals were studied under abnormal physiologic conditions or the bowel was subjected to mechanical irritation.

To overcome these objections, isolated segments of the colon were transplanted to the abdominal wall where they could be observed under all conditions over long periods of time without the use of anesthesia or mechanical irritation. The dogs were prepared by isolating segments from the upper, middle, and lower colon. Studies were directed toward the determination of normal movements of the dog's colon in the fasting state and after feeding and the effect of the following drugs upon these movements: pitressin, morphine sulfate, atropine sulfate, prostigmin, 0.85 per cent sodium chloride, 20 per cent sodium chloride, and 50 per cent glucose.

Magnus¹¹ and later Alvarez¹ made valuable observations of intestinal motility by taking full-thickness strips from various parts of the intestinal tract and immersing them in Locke's solution. The solution was kept at a constant temperature and was oxygenated. The rate of contraction of the immersed strips was noted. Numerous drugs were added to the solution and the effect on the rate of contraction recorded. Alvarez found that the average rate of contraction of the duodenum was 15.3 per minute; of the jejunum, 13.3; of the upper ileum, 10.5; and of the colon, 6.8 per minute. From these observations he developed his gradient theory of intestinal motility.

Jacobj,⁸ in 1890, was the first to report antiperistaltic movements and these observations were confirmed by Cannon⁵ in 1901. Fluoroscopic observations were carried out on the cat following a barium meal. Cannon states that antiperistaltic waves set in soon after food enters the colon and continue for periods of two to eight minutes at a rate of five waves per minute. After these have been occurring for some time,

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serial sectioning of the contents begins and is followed by gentle kneading movements. Cannon describes very accurately the sudden mass movements of the column of bismuth which is then split up into a number of equal segments. Within a few seconds each of these segments is again divided, and at times, these smaller segments are redivided so that every particle of food is brought into intimate contact with the intestinal wall. These segmental movements have nothing to do with the forward progress of food. Starling¹⁹ states that the forward progress is caused by a true peristaltic contraction which involves contraction of the intestine above the food mass and relaxation of the intestine below. To prove his theories he inserted balloons into the lumen of the exposed colon and found that by pinching the colon above the balloon an immediate relaxation of the muscle wall in the neighborhood of the balloon took place. He showed that stimulation at any point of the colon causes contraction above and relaxation below the point of stimulus. This reaction is termed by Bayliss and Starling⁴ the "law of the intestine."

Considerable effort has been made to analyze various functions of the longitudinal and circular muscle layers. It is felt that only by a thorough understanding of the action of these layers could the above reaction be explained. Raiford and Mulinos,¹⁷ in 1934, devised a series of experiments in which they could record separately on a smoked drum the movements of the circular and longitudinal muscle layers. This was accomplished by exteriorizing isolated segments of colon 8 to 10 cm. in length, opening them longitudinally and, after excising an equal area of skin from the abdomen, suturing together the mucosal and skin edges. Continuity of the remaining bowel was re-established by end-to-end anastomosis. After a period of time it was found that mechanical stimuli, such as light stroking, would produce light contractions of the longitudinal and circular layers. Clips were attached either longitudinally or transversely and connected with a recording mechanism. From these experiments they concluded that stimulation of the mucosa of the colon caused contraction of the longitudinal muscle at and below the point of stimulation but none above it, followed by contraction of the circular muscle at and above the point of stimulation but none below. This dilates the bowel lumen below the stimulus and constricts it above, thus facilitating the downward passage of intestinal contents. Raiford and Mulinos also observed that, following the ingestion of food, the colon transplant seemed more irritable, so that weaker mucosal stimuli elicited more powerful and lengthy contractions of the intestinal musculature. They concluded that the "law of the intestines" depended upon mucosal stimulation.

Barcroft and Steggerda³ studied the exteriorized cecum and proximal colon not disconnected from the remaining intestine. In the fasting state they observed definite kneading contractions followed by

deeper contractions involving the whole cecum and progressing toward the ileocecal region. After several such contractions, a marked constriction existed in the region of the ileocecal valve and remained for three to four minutes, resulting in considerable distention of the colon. Shortly thereafter, antiperistaltic waves appeared at the rate of five to seven per minute. The cecum then began to relax and deep kneading contractions progressed down the colon, stopping the antiperistaltic waves. They also observed deep, massive contractions originating in the ileocecal region and passing slowly down the colon, forcing intestinal contents before them. Faint antiperistaltic waves preceded these contractions. Approximately fifteen minutes were usually required for a wave to travel the length of the exposed colon. Following feeding, pronounced contractions were noted first in the ileocecal region and were followed by antiperistaltic waves and later by kneading contractions. Similar series of contractions recurred repeatedly for perhaps ten minutes, the cecum during this time remaining inactive.

Templeton and Lawson²¹ studied the normal motility of the dog's colon by the use of tandem balloons inserted through a cecostomy and into the anus. They observed three types of contractions: Type I, a rapid contraction which appeared on the tracing as a simple curve; Type II, a slower contraction surmounted by the more rapid Type I contractions; and Type III, tone changes usually surmounted by Type II contractions. The relationship of these three types of contractions suggested that the larger contractions resulted from a summation of the smaller. Rhythmic pulsations which were converted into waves appeared to be the fundamental activity of the dog's colon. Certain differences were noted in the activity of the proximal and distal colon. High tone changes with periods of activity prevailed in the proximal colon. The distal colon showed only slight tone changes. They noted a reciprocal relationship between certain types of activity in the proximal and the distal colon.

Larson and Bargaen¹⁰ studied the motility of the isolated colon prepared by a two-stage procedure which united the terminal ileum to the distal sigmoid. The intervening colon, comprising all but a small distal segment, remained within the abdominal cavity with a cecostomy and the proximal divided end of the sigmoid open on the surface of the abdomen. Motor function was studied by a tandem set of three balloons attached to water manometers, one balloon being in the cecum, one near the splenic flexure, and the third in the lower sigmoid. The colon was found normally to be practically quiescent and active only when definitely stimulated. "When movements took place they consisted mainly of three types of waves: (1) large tonus waves at the rate of six to eight an hour; (2) small tonus waves surmounting the large and coming at the rate of five to six in four minutes; and (3) short rapid contractions superimposed on the small tonus waves and

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served in dogs. Barcroft and Steggerda³ studied the effect of morphine on loops of exteriorized colon. One-half cubic centimeter of 5 per cent solution of morphine was injected subcutaneously and vomiting and defecation were observed to take place one hour later. The cecum and ileocecal region were the only portions of the gut to show any movement and these were very weak and occurred only occasionally. They also reported an increase in the tone of the colon of the dog. The method of Plant and Miller¹⁵ was used by Yonkman, Hiebert, and Singh²² in studying the effect of morphine on the human colon. Long, sausage balloons were placed in the lumen of the bowel through colostomies and attached to a recording kymograph. All patients studied showed some form of stimulation of either the ileum or the colon following the administration of morphine, the results varying with the individual patient, the dosage of morphine, and the bowel area studied. Straub and Schild²⁰ studied the action of morphine on the motility of the colon of guinea pigs by attaching a water manometer to the desired segment of colon. They reported an increased tonus with small doses of morphine (0.2 to 0.75 mg. per kilogram of body weight) and an arrest of peristalsis in most cases. Small doses seemed to increase tonus as well as large doses. Alvarez² reported an increase in the motility of excised, full-thickness strips of rabbit colon immersed in warm, oxygenated Locke's solution to which 5 c.c. of a 1 per cent solution of morphine sulfate had been added.

Ochsner, Gage, and Cutting¹² have conducted extensive experiments on the effect of drugs on the intestine of the normal dog and in dogs with obstruction at the terminal ileum. In their experiments dealing with the colon as well as the ileum, physostigmine, pituitrin, pitocin, peristaltin, and acetyl choline were used. Of this group of drugs, physostigmine produced a definite increase in tone and intestinal movements of the ileum and an increase in movements of the colon with practically no change in tone. In the normal dog pituitrin had a definite, though slight, tendency to produce decrease in tone and inhibition of peristaltic movement in the ileum as well as colon. When pitocin, peristaltin, and acetyl choline were given to normal animals, the effect on the ileum and colon was relatively the same, showing no change or a slight decrease in tone and activity. This led the authors to the obvious conclusion that in general the treatment of ileus by drugs could not be looked upon as a very effective therapy. Ochsner, Gage and Cutting¹³ conducted additional experiments on the effect of morphine on the small intestine of the normal dog and found that it increased tonus and activity just as it did in the colon of animals in the experiments of the authors and other investigators.

The action of prostigmin on the motility of the colon of guinea pigs was studied by Straub and Schild.²⁰ They found this drug to be a very effective stimulant to the motility of the small intestine but noted

with a rate of eight to ten a minute. The latter were found almost entirely in the cecum and probably represent a mixing or churning type of movement which is usually present in this segment of bowel. The waves could not be followed with certainty from one end of the colon to the other although they seemed to travel analward in many instances. Usually the whole organ contracted systolically as a unit." Feeding meat to fasting animals produced a gastrocolic reflex, the colon contracting strongly for fifteen to twenty minutes, especially in the distal segment. They also noted a receptive relaxation of the cecum on feeding. Waves of contractions in the colon were observed preceding vomiting.

Medical literature reveals a number of reports relative to the action of drugs on movements of the colon. Alvarez² studied the effect of pituitrin placed in the water bath of the excised full-thickness strips of the colon of rabbits and found slight contractions with a moderately strong concentration of the drug. Larson and Bargaen,¹⁰ studying movements in isolated dogs' colons by the use of tandem balloons, observed that pituitary solutions administered subcutaneously moderately increased the activity of the middle portion but had little or no effect on the distal colon. Patients who had been subjected to colostomy and ileostomy were observed by Guthrie and Bargaen,⁶ who introduced rubber balloons into the lumen of the transverse colon, sigmoid flexure, and terminal ileum. The normal tracings of the transverse colon showed continual small contractions which were not normally present in the sigmoid flexure. In all segments of colon and ileum studied, they found that pituitrin produced powerful peristaltic contractions without apparently exerting any effect on tonus. Strong contractions began a few minutes after administration of the drug and were accompanied by borborygmus, abdominal cramps, and the expression of large amounts of feces from the colonic stoma. No other drug studied was found to have as constant and marked an effect. Seed, Falls, and Fantus¹⁸ distended the colon of human patients with air to the point of discomfort. Pressure changes in the colon were recorded by manometers connected to a rectal tube. The intramuscular injection of pitressin was followed by strong colon contractions.

Plant and Miller¹⁵ have studied the effect of morphine upon the motility of the colon in dogs and in the human. In their studies on dogs Thiery-Vella loops of colon were prepared and balloons attached to a recording mechanism were inserted. They concluded that morphine produces a marked increase in the tone of the dog's colon and more continuous peristaltic activity, though no change in the rate and amplitude of peristaltic waves was noted. The small rhythmic contractions of the colon corresponding to Type I contractions were not altered by opiates. Studies were made on the human colon through colostomies. They obtained results that were similar in every respect to those ob-

ficiently mobile to permit the removal of a 10 cm. segment without placing too much tension upon the anastomosis. Several other operations failed because too great a tension was exerted upon the mesentery of the transplanted segment. The ileocecal region was usually fixed deeply in the abdomen and only in rare instances did it have a mesentery of adequate length to permit its transplantation to the skin surface.

The dogs were kept on a milk diet for three days prior to operation. The colon was thoroughly washed out with warm water one hour pre-operatively. All operative procedures were performed under sodium pentobarbital anesthesia administered intraperitoneally. The abdomen was opened with aseptic technique by a 10 cm. midline incision. The omentum was pushed upward and to the left. The colon was usually found deep in the abdominal cavity just below the greater curvature of the stomach. The selected area was walled off with sterile, wet laparotomy pads and a segment of colon as long as possible was removed between clamps. This was usually 8 to 10 cm. in length. The mesentery was split down to the base, care being taken not to impair the blood supply. Continuity of the bowel was re-established by end-to-end anastomosis using 000 intestinal catgut on atraumatic needles. The mesentery was closed to the base to avoid the possibility of subsequent internal hernia. Omentum was placed around the anastomosis. The peritoneum and fascia of the abdominal wall were closed in layers under the transplanted segment, using mattress sutures of No. 1 chromic catgut tied loosely so as not to strangulate the blood supply. The skin in many cases was not sutured as the incision usually was not longer than the segment. The area was dressed with sterile gauze which was removed on the second day, after which no further dressing was needed.

Various portions of colon were selected in the five dogs used in this study. In Dogs I and II segments were taken as close to the ileocecal junction as possible, in Dog I the proximal end being 2 cm. from it. The segments in Dogs III and IV were isolated from 8 to 10 cm. distal to the ileocecal junction, and in Dog V the segment was taken from the lower colon. The blood supply of Segments I and II was derived from the right colic artery and that of III and IV from the middle colic artery. Segment V received its blood supply from small branches of the marginal artery.

The dogs were fed a milk diet for the first few days after operation and a low residue diet thereafter. All five dogs remained in excellent health throughout the duration of these experiments, which covered a period of eight to twelve months.

In studying the types of movements found in the colon segments, we were confronted with the difficulty of finding a satisfactory means of recording them. Considerable time and effort was spent in attempting to record movements by the use of electrograms as had been employed

little effect on the large intestine. Pichler¹⁴ reported his observations on the clinical use of prostigmin. The effect on the colon was deduced only by clinical results. He concluded that prostigmin increases the excitability of the intestine in such a manner that it reacts strongly to lesser stimuli for a long period.

Alvarez² reported a slight increase in the motility of excised, full-thickness strips of rabbit's colon which were immersed in warm oxygenated Locke's solution to which 4 c.c. of glucose had been added. He followed the same procedure to determine the effect of concentrated saline solution, adding 5 c.c. of a 26 per cent saline solution to the bath, and found that it did not produce any change. Twelve cubic centimeters produced strong contractions. Larson,⁹ working with Thiery-Vella loops of dog's colon, reported extremely strong and sustained contractions following the intravenous injection of 20 per cent sodium chloride. Concentrated saline solution produced much stronger contractions than did pituitrin or acetyl choline.

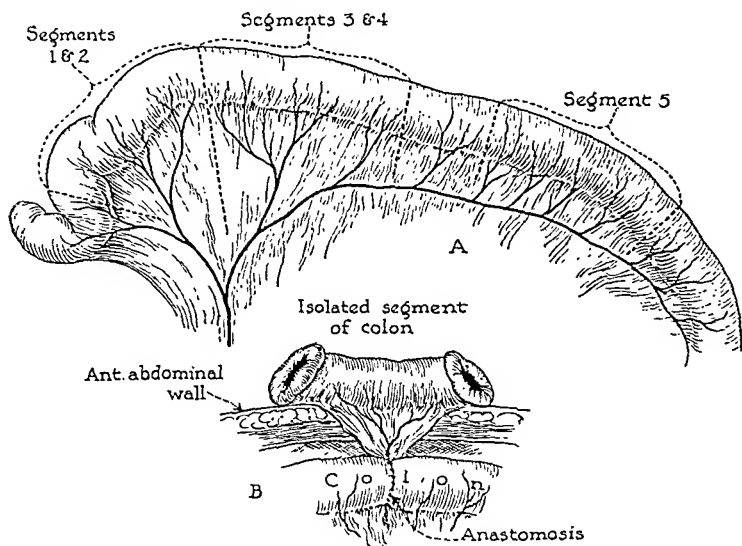


Fig. 1.

METHOD OF STUDY

Female dogs weighing 15 to 25 kg. were selected for this study. Large, long-haired dogs were found to have a relatively long mesocolon and a more redundant colon. These factors were important as they permitted an isolated segment of colon to be transplanted to the surface of the abdominal wall with its mesentery intact and also allowed continuity of the remaining colon to be re-established by end-to-end anastomosis without undue tension on the suture line (Fig. 1). Several dogs which were operated upon died because the colon was not suf-

had returned to normal color. The same observations were repeated on the denervated segment of each dog. Six or more separate observations were made on each segment following fasting, feeding, and the administration of the drugs previously mentioned.

RESULTS

Twelve to twenty-four hours were allowed to elapse following the last feeding before observations were made to determine the effects of fasting upon motility of the colon. A few studies were made after thirty-six- and forty-eight-hour fasts, but very little or no difference could be seen between these and the shorter periods. As previously stated, all segments were found to be contracting when the dogs were first placed upon the side-racks. When, after a few minutes, the segments became relatively inactive, the experiments were started. Sufficient time was allowed to elapse between experiments to permit the effect of drugs used in previous observations to wear off.

The normal contractions of the segments of colon seen in the fasting animal, using the terminology of Templeton and Lawson, can be described as Types I, II, and III.

Type I.—These were very light contractions, appearing as indistinct muscular twitchings and seeming to involve only the circular muscle. They were observed as small localized contractions involving only a portion of the circumference of the segment, thus producing a faint surface dimpling. They did not appear to progress up or down the segment as peristaltic or antiperistaltic waves. These contractions started slowly, one to two minutes apart, and increased in frequency until they occurred three times per minute, continuing at this rate for two to four minutes and then slowly subsiding. At times they were seen at irregular intervals as one or more unrelated contractions. This type of contraction was seen most frequently in the proximal third of the segment of Dog I and in Dog II, less frequently in Dogs III and IV, and rarely in Dog V. Occasionally the proximal end of Segment I would blanch slightly with these contractions. Only after several months of observation was it finally decided that these contractions were part of the normal movement of the colon of the dog.

Type II.—These consisted of deeper contractions which would start at the proximal end of the segment, generally following a few Type I contractions, but occasionally not preceded by them. Type II contractions could be recognized as distinct circular indentations progressing to the distal part of the segment. They were seen much less frequently than Type I contractions and were interspersed with them. They were found to recur every fifteen to thirty minutes in Segments I and II, every twenty to forty minutes in Segments III and IV, and even less frequently in Segment V where they did not recur at any definite time

previously on the small intestine.¹⁶ Some electrograms were made, but the movements in the colon were so slow and irregular as to make this method of study impracticable. Balloons were not placed in the lumen of the segments because it was believed distention would alter the responses. Motion pictures were not used because of the irregularity, slowness, and infrequency of the colon movements. Graphic records, although convenient, present mechanical difficulties in representing the true activity of the organ and are often misleading. We concluded, therefore, that direct visual observations and a descriptive tabulation of them gave us the most accurate and satisfactory data.

As extraneous noises disturbed the dogs, observations were conducted in a quiet laboratory maintained at room temperature with the animals lying on side-racks. The duration of each observation was from one to four hours. The segments were always found to be moist and of normal pink color when the observations were started but tended to dry out considerably during long observations. To overcome this, they were moistened occasionally with warm physiologic saline solution from a medicine dropper.

The segments were always active immediately after placing the animals upon the rack, and, for this reason, observations were not recorded until the segments had become quiet, usually ten to fifteen minutes later. Likewise, observations which were carried out for several hours did not seem to be as accurate as those taken within the first two hours. Some dogs became very restless when observed for more than two hours at a time. Dog V was watched for a period of eight hours and did not show any contractions after the first two hours, the dog remaining fairly quiet during the entire period. Observations were generally made after a twelve- to twenty-four-hour fast. Occasionally the dogs were fed immediately before or during a study to note the effect of feeding and the presence or absence of a gastrocolic reflex. Studies were made before and after the administration of pitressin, atropine sulfate, morphine sulfate, prostigmin, 20 per cent saline solution, 0.85 per cent saline solution, and 50 per cent glucose.

After all observations were completed, the dogs were again operated upon and the mesentery to the isolated segments divided. The same sterile technique and the same anesthesia were used. The abdomen was opened by a small incision 3 cm. to the right of the segment, care being taken not to disturb the collateral blood supply which had developed from the abdominal wall. The abdominal cavity was found to be relatively free of adhesions. The mesentery to the segment was identified, ligated, and divided. The abdomen was closed in the usual manner. This procedure was carried out to divide all remaining nerve fibers between the colon segment and the central nervous system. The segments became slightly cyanotic, but, by the end of two days, they

MORPHINE SULFATE

A great many observations were made after the intramuscular administration of morphine sulfate. With dosages of 0.4 and 0.8 mg. per kilogram of body weight, nausea and vomiting always occurred in four to six minutes, five minutes being the average. Types I and II contractions started three to four minutes after injection and continued with only short intermissions for thirty to forty minutes. Eight to ten minutes after injection Type III movements were noted and were seen to recur every five to ten minutes. The principal difference in 0.4 and 0.8 mg. doses per kilogram of body weight was the length of time the segment was seen to contract. Movements usually continued for thirty to forty minutes following the use of 0.4 mg., while 0.8 mg. produced contractions for sixty to seventy minutes, there being very little difference in the type or frequency of them. Borborygmus was frequently audible during this time. It was very evident that morphine sulfate stimulated increased activity of segments of dog's colon under the experimental conditions employed.

We watched a few segments for one to two hours after the effects of morphine had subsided to see if the segment contracted less frequently or became more relaxed than normal. We were unable at any time to note any secondary depression of activity.

ATROPINE SULFATE

Following the administration of atropine sulfate in dosages of 0.016 mg. per kilogram of body weight very slight or no increase of muscular activity of the colon segments was noted. At times the muscle tonus appeared stronger and Type I contractions seemed to be more frequent. Types II and III contractions were not seen after the use of atropine. The tonus of the segments appeared to remain about normal.

PROSTIGMIN

Prostigmin was injected intramuscularly in 1 c.c. doses of a 1:2,000 solution and in every instance was followed by Type II and later by Type III contractions. Borborygmi were audible and frequent during the height of the action of this drug. Type II contractions began ten to fifteen minutes after the injection of prostigmin, followed in ten minutes by Type III contractions and continued with only short periods of relaxation for one to two hours. Frequently the segment remained in a state of tonic contraction for periods of five minutes. Type III contractions were the predominant type of movement following the use of prostigmin, while very few Type II contractions were noted. In the dosages used, the segment appeared to go into spasm and remain so tightly contracted that we doubt very much if propulsion of contents could take place. Morphine produced many Type II contractions with some Type III, while prostigmin exhibited mainly Type III contractions.

interval. Type II contractions would travel the length of the segment in three to five minutes. The depth of the contracting band varied somewhat as did the rate of progression down the segment.

Type III.—Sometimes the entire segment was seen to contract as a whole. This usually occurred unassociated with other contractions, although it was preceded at times by Type I or Type II contractions. The segment during this type of contraction can best be visualized by first describing it at rest. The segment had a deep pink color with both ends widely dilated and containing a plug of mucus. At the beginning of Type III contractions, the mucous plug would be extruded from both ends, the lumen becoming smaller, and the color fading to a lighter shade of pink. The segment was definitely elongated (a circular contraction). Suddenly it would become shorter and thicker (a longitudinal contraction). At other times the segment appeared to shorten in length, grow smaller in diameter, and become paler in color than normal. This was interpreted as simultaneous contractions of both circular and longitudinal muscles. The segment was seen to go through all three of these stages in quick succession and slowly return to the normal quiescent state. There was no definite rate of occurrence of Type III contractions. We have seen them occur two or three times in a three-hour observation period and have watched the same segment on other days without seeing a single one. They were noted more frequently in Segments III, IV, and V than in Segments I and II, although they did occur in the latter. Type III contractions occurred so irregularly and infrequently that it was only after observing them following the administration of morphine, prostigmin, and 20 per cent saline solution that we concluded they were a part of the normal movement of the colon. If observations could have been extended over a period of eight to twelve hours without the dogs becoming restless, a definite rate of occurrence might have been noted. In this paper movements will be designated as Type I, II, or III, according to the above description.

PITRESSIN

Six observations were made on each of the five segments following the intramuscular injection of 0.5 to 1 c.c. of pitressin. Observations were begun after the administration of one-half ampule (10 pressor units), and very little or no increase in movement was noted. Later one full ampule (20 pressor units) was used in each experiment. Some slight increase in movement was noted. All segments seemed to have an increased tonus, indicated by a slight diminution in the size of the lumen. Increased movement was noted in Segments III, IV, and V on certain days, but, on the whole, we do not feel that pitressin definitely increased the number of movements in the segments studied.

and Lawson and in this study, and the large and small tonic waves of Larson and Bargaen carry the contents into the next segment. Here the process is repeated until the contents reach the distal colon. The experiments of Barcroft and Steggerda are better adapted to show continuity of movement than any of the others since the waves of contractions can be seen with the eye to slowly progress down the bowel. Likewise, after feeding, the cecum can be seen to remain relaxed while the more distal part is contracting. The work of Templeton and Lawson and of Larson and Bargaen shows progression of movement from one balloon to another and the relaxing effect of the cecum, but their work is especially adapted to the analysis of these movements.

In recording the results of our experiments, we have adopted the terminology of Templeton and Lawson as best fitted to describe our observations. Their Type I small, rapid contractions are very similar to those we have observed and described and designated as Type I. Some of these may or may not be antiperistaltic contractions. We did not see any Type I contractions as frequent as eight to ten per minute as they describe. We observed contractions as often as every twenty seconds, and when they occurred more frequently than this, we could not distinguish them as separate contractions. Larson and Bargaen describe small tonic contractions recurring eight to ten times per minute, which coincides with the observations of Templeton and Lawson. This also agrees with Cannon's observations on small waves recurring two to eight times per minute.

Type II contractions of Templeton and Lawson and of our observation are similar to the small tonic waves observed by Larson and Bargaen. These Type II contractions are the same as described by Starling¹⁹ and designated by him as true peristaltic waves. He describes them as occurring at about the same frequency as seen in these studies. Barcroft and Steggerda describe Type II contractions as deep contractions with a slow rate of progression requiring fifteen minutes to travel the length of the exposed portion of the colon. This is about the same rate of progression as we observed. They do not state how frequently they recur but imply that they are infrequent.

Holzknacht⁷ was the first to describe mass contractions which are the same as the Type III contractions of Templeton and Lawson and of this study. Larson and Bargaen describe them as large tonic waves and Barcroft and Steggerda call them mass contractions. Templeton and Lawson and Barcroft and Steggerda do not say how frequently they are observed. Larson and Bargaen state that they occur six to eight times per hour and last for five minutes. They state that these large tonic waves can be produced at will by increasing the pressure in the balloons. This suggests the possibility that the mechanical irritation of the balloon might have produced some of the contractions since they have not been

SODIUM CHLORIDE

No noticeable increase or decrease in the normal motility of the colon in any of the five dogs followed the intravenous injection of an 0.85 per cent solution of sodium chloride. Twenty cubic centimeters of 20 per cent sodium chloride solution was injected intravenously into Dog V, followed immediately by violent struggling and then a partial cessation of respiration. The dog became cyanotic and completely relaxed. Artificial respiration was given and after a few minutes the dog slowly returned to normal. During all this time, the segment remained in a state of tonic contraction. After fifteen minutes the segment began to slowly relax. After three hours the segment was still more contracted than normal. Most contractions were tonic in character with almost no Type I or II contractions. A large dose of saline solution was not injected again for fear of killing the dog. Ten cubic centimeters of a 20 per cent saline solution was injected slowly and after a few minutes this was repeated. Four to five minutes later, Types I and II contractions began, followed by Type III contractions, then by short periods of relaxation. This sequence continued for about one hour, after which contractions slowly subsided. However, the tonus of the segment remained increased for a longer period of time. Ten cubic centimeters of 10 per cent saline solution was found to be sufficient to produce the above sequence of events, although the contractions continued for a shorter duration of time. The tonus remained increased for about the same length of time.

GLUCOSE

Glucose in dosages of 20 c.c. of 50 per cent solution was injected intravenously in all five dogs and in every instance one or more Type III contractions took place four to five minutes after the injection. The tonus remained increased for fifteen to twenty minutes, following which the segments returned to normal.

DISCUSSION

Upon considering in general the results of these experiments, it is interesting to note the many similarities and the slight differences between our observations and those reported in the literature. The experiments of Barcroft and Steggerda,³ Templeton and Lawson,²¹ and of Larson and Borgen,¹⁰ together with our own, present different aspects of the motility of the colon of the dog. A more accurate understanding of it may be obtained from a composite picture of all of these studies. Barcroft and Steggerda demonstrated the presence of antiperistalsis in the dog's colon. They gave a clear picture of the to-and-fro shifting of bowel contents by kneading and by peristaltic and antiperistaltic contractions until the mass is of a certain consistency. Then the Type II or Type III contractions, as described by Templeton

the proximal colon. Type II consists of a contraction of the circular musculature which progresses slowly down the colon for varying distances. It is a true peristaltic wave and may occur two to four times an hour. Type III is a mass contraction involving circular and longitudinal muscle layers and occurring two to four times in twenty-four hours. Very little response was noted following feeding. The gastrocolic reflex was not found to be present in this series of experiments.

Pitressin, in 20 pressor unit doses, was found to increase tonus but had very little effect on the movements of the dog's colon.

Morphine sulfate increased the tonus and frequency and strength of contractions of the dog's colon. Atropine had little if any effect on motility.

Prostigmin in the doses used always produced uniform maximum contractions. This varied from marked increase in tonus to a state of tonic contraction. Of all the drugs used, prostigmin gave the most uniformly strong contractions.

Physiologic saline solution had very little, if any, effect on the motility of the dog's colon. Concentrated saline solutions (10 to 20 per cent) produced a marked increase in tonus and a marked increase in the number and strength of contractions.

Fifty per cent glucose usually produced an increase in the movement of the colon which was of short duration.

The same results as mentioned above were obtained after cutting the mesentery to the segment and repeating all observations.

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observed by others to occur so frequently. Previous experiments¹⁴ have shown that balloons produced maximal and regular contractions in small bowel segments.

Barcroft and Steggerda state that there is evidence of a gastrocolic reflex appearing within a few minutes after feeding but do not state how this takes place. Larson and Bargaen describe the gastrocolic reflex and the sequence of events after feeding but state that it is best elicited by fasting the animal for twenty-four hours and making observations at a time when the bowel is likely to be full of feces. They state that the reflex may be absent when the distal colon is empty. Cannon concluded from his fluoroscopic observations on the cat that the cecum remains quiet for a few minutes following the taking of food, while the distal colon becomes more active. Within a few minutes, peristaltic and antiperistaltic waves set in and continue for some time. We were unable to demonstrate any definite change in motility of the colon following the ingestion of food, although at times indefinite variations in activity were seen.

Larson and Bargaen report moderately strong contractions following the administration of pituitrin in the dog's colon. They do not state the dosage used or the type of contractions produced. In our studies on isolated segments of the colon of dogs, we did not find that pitressin stimulated contractions to any noticeable degree although it did increase tonus slightly. Our observations on the action of morphine on the motility of the dog's colon coincide very closely with the observations of Plant and Miller.¹⁵ This drug, in the doses used, always produced an increase in tonus and in the movements of the dog's colon. Atropine sulfate did not increase the movement of the dog's colon. Whether or not it inhibited movement or decreased the tone of musculature of the colon could not be determined. Alvarez² reported a decrease in movement from his observations on the use of atropine on excised full-thickness strips of the cat's colon.

Our observations on the action of concentrated sodium chloride coincide with the observations of Larson on the movements of the colon. Strong sustained contractions always followed the intravenous injection of concentrated sodium chloride solutions.

SUMMARY

Direct observations of the motility of isolated segments of dog's colon transplanted to the surface of the abdominal wall in survival experiments were made. Three different types of normal movement were found in these isolated segments of the colon. Type I consists of small waves produced by contraction of the circular musculature, serving to mix the bowel contents and having nothing to do with propulsion of the fecal mass. These small contractions when present may occur every twenty to forty seconds and are found most frequently in

STUDIES OF INTESTINAL MOTILITY: THE EFFECT OF INTRAVENOUS SOLUTIONS AND OF INSULIN UPON PERISTALSIS

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RECOGNITION of the importance of fluid and chemical balance and of an adequate state of nutrition of surgical patients has resulted in extensive use of fluid therapy. The oral, rectal, and subcutaneous routes so frequently are unable to handle fluid administration at the desired rate or concentration that intravenous infusion has become widely adopted. It is important for us to know what effects this form of therapy may have upon other physiologic processes which may influence surgical morbidity. One of the most important of these is intestinal motility because of its relationship to distention, gas pain, nausea, vomiting, and nutrition.

Physiologic saline solution intravenously has been used extensively and its stimulating influence upon intestinal motility is recognized. Various concentrations of dextrose are administered often in sterile water or in combination with numerous salts. It has been suggested, however, that dextrose by vein has a depressant action upon the gastrointestinal tract and may play a part in paralytic conditions of the bowel. Insulin has been advocated to aid in the utilization of dextrose. As considerable controversy exists concerning the action of these solutions upon the intestine, the following experiments were performed to obtain corroborative evidence. The studies were limited to the use of physiologic saline solution, 10 per cent dextrose, insulin, and combinations of them. Dogs were prepared with isolated segments of small intestine exposed on the surface of the abdomen. Such preparations permitted prolonged and repeated observations on survival animals which were in apparent good health.

Intestinal segments of the lower jejunum and of the ileum were transplanted to the anterior abdominal wall by a previously described operation.²¹ The abdomen was opened through a low midline incision under general anesthesia and with aseptic technique. The small intestine was delivered through the incision, and a segment of bowel approximately 10 cm. in length was isolated and transplanted onto the abdominal wall, keeping the mesentery intact. The continuity of the remainder of the gastrointestinal tract was restored by end-to-end anastomosis. Observations upon peristaltic activity of the segment were made after inflammation of the segment had subsided.

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enteric activity more marked in the hypertonic dilutions. Their experiments were conducted upon dogs in which an artificial mechanical obstruction to the gut had been produced. The terminal ileum was the segment of bowel selected, and an enterostomy tube was inserted proximal to the obstruction. Evidence was also presented that the obstructed gut reacted more readily than did the normal.

On the other hand, Dreyer and Tsung (1929) and Orr and his associates (1931) could not demonstrate any change in intestinal activity following the injection of physiologic saline solution. Dreyer and Tsung worked with chloralosed cats, the intestines of which were immersed in a warm bath of Ringer's solution and kymographic tracings were taken of the existing activity. They observed isotonic saline solution to produce no demonstrable effect upon contractions. Hypertonic sodium chloride (3.6 per cent), however, produced a stimulation of peristalsis of 4 minutes' duration.

Orr, using dogs having Thiry-Vella loops and jejunal fistulas, confirmed the work of Dreyer and Tsung. Hypertonic saline solution was found to increase the tone and peristaltic activity of the jejunum. No change in intestinal activity could be demonstrated by them following the use of physiologic saline solution. Orr, Johnstone, and Haden observed similar effects in a confirmatory group of experiments. They found stimulation to follow the intravenous injection of hypertonic (5 to 10 per cent) solutions, but noted no alteration in activity subsequent to the use of isotonic solutions.

Experimental Findings.—In our experiments, visual observations begun immediately after the inauguration of drip phleboeclysis with physiologic saline solution and maintained for a twenty-minute period showed a sharp sustained rise in the frequency of the contractions of the segment. In general, the contractions occurred at a rate approaching a maximum throughout the experiment. Graph 1 shows the mean of eleven experiments.

Associated with increased rate of activity was a concomitant increase in the secretion as evidenced by drippings from the open end of the segment and the occasional forceful expulsion of accumulated secretions from within its lumen. The contraction rings themselves, in most instances, appeared deeper and more forceful.

The complete series of experimental findings was arranged in tabular form as shown in Table I, listing the number of peristaltic contractions for each minute of control and for the experimental time for each of the eleven observation periods in this group. From this tabulation it was possible to arrive at total and mean values for each minute, the latter being illustrated by the graph. By comparing control and experimental times it will be noted that no particular attempt was made to administer the solution only when the bowel was relatively inactive. It was hoped

The observations, which were continuous, extended over a fifteen-minute control period, followed by a twenty-minute period during which the solution was being administered. The control period was used in each individual experiment to provide a relative basis for comparison. The solutions were injected by means of a drip apparatus and with standard hospital technique. Infusion was made into the external saphenous vein at the rate of eighty drops per minute. The experimental time was initiated at the beginning of the infusion. The dogs were unanesthetized and trained to lie quietly upon the side-rack tables for the duration of the experimental proceedings. Almost complete reliance was placed upon direct visual observation of the segments, and a record was made of the number of peristaltic contractions per minute. A series of from seven to eleven similar experiments was carried out for each solution used, and the average number of contractions for each corresponding minute of the control and experimental period was determined. The accompanying graphs were drawn from these computations.

In addition, electrographic tracings were taken at specified intervals, using a previously described technique.²² Electrical contact was established by the direct application of two platinum electrodes to the serosal surface of the isolated segment. These records, however, portray only brief periods of activity of the segment and, for this reason, were not felt to be as satisfactory as the visual observations which were continuous. Electrographic tracings were taken during the control period and were repeated several times throughout the course of the experiment. In general, these findings substantiated the visual observations.

PHYSIOLOGIC SALINE SOLUTION

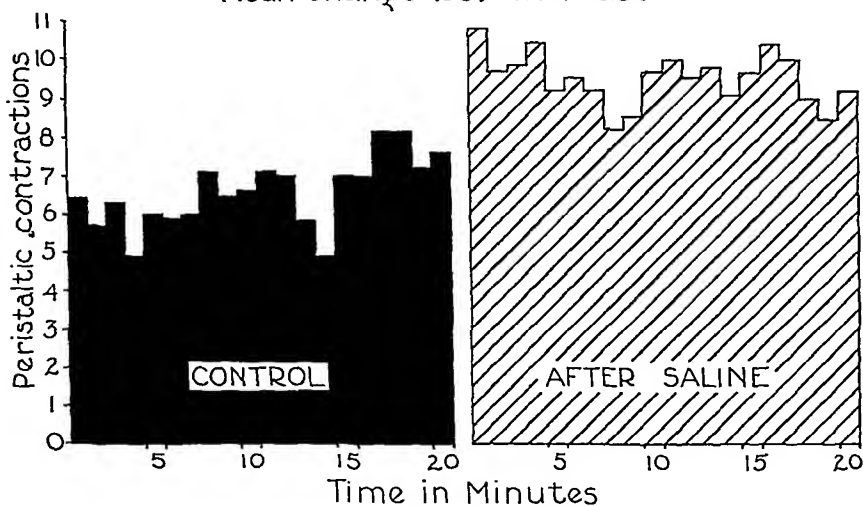
Literature Review.—Since Hughson and Scarff in 1924 first demonstrated that intravenous hypertonic saline solution has a stimulating effect upon the bowel, ample confirmatory evidence by various authors has been presented. That clinical results were in keeping with experimental findings was indicated by Ochsner and co-workers (1933) in their excellent review of the literature on the subject. However, experimental findings as to the value of physiologic saline solution as an intestinal stimulant have been contradictory. Hughson and Scarff, in their original article, reported an increased activity following the intravenous injection of physiologic saline solution, although not to the same degree as that subsequent to hypertonic solutions. Their observations carried out on cats were made directly upon jejunal segments filled with tap water under varying degrees of pressure. The animals were anesthetized for the duration of the experiment.

Ochsner, Gage, and Cutting (1930, 1933) obtained similar results with Ringer's solution. This solution also produced a stimulation of

that, by infusing the fluids when the bowel was active, any depressing effect would be elicited more readily.

In Experiments 1 and 11 the peristaltic activity in the segments was proceeding at a maximum rate. The infusion by vein of physiologic saline solution had no consistent depressing effect on this activity. On the other hand, in Experiments 2 and 10 in which the segment was totally inactive during the control period, the phlebotomy of physiologic saline solution immediately inaugurated vigorous peristalsis, often attaining a maximum rate. In the majority of cases the increase was to a maximum rate of activity of variable duration.

Physiological Salt Solution-Continuous Drip Venoclysis
 Mean control 6.57 Mean record 9.46
 Mean change 2.89 increase



Graph 1.

In reviewing the findings, one notes that there occurred only one instance (in Experiment 1) in which a depression of activity occurred. The drop in activity, however, was only temporary and may have been due to factors other than the saline infusion, such as a physiologic rest period. In only Experiment 11 there was no marked change from the control. The other nine experiments all demonstrated an increase in the rate of activity to a greater or lesser extent.

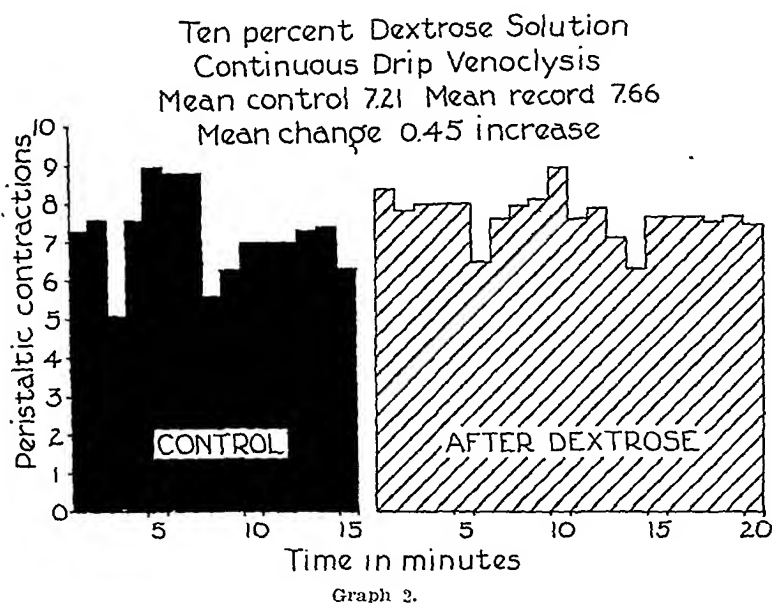
TEN PER CENT DEXTROSE SOLUTION

Literature Review.—The effect of intravenously injected dextrose solution upon the activity of the bowel is still a controversial subject. In reviewing the literature one is impressed by the lack of agreement between the various investigators. Results varying all the way from stimulation to inhibition have been reported. Neukirch and Rona (1912),

TABLE I
PHYSIOLOGIC SALINE SOLUTION

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Before Administration</i>																				
1.	14	13	12	12	12	13	13	12	13	13	12	12	12	11	12	12	12	12	12	11
2.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	4	5	3	1	7	10	10	6	7	3	2	6	6	2	4	0	0	0	0	0
4.	3	0	4	9	7	4	8	6	7	6	8	5	0	5	9	8	7	7	7	7
5.	5	0	7	0	9	9	3	9	6	7	9	8	13	10	4	-	12	10	8	11
6.	8	6	5	4	3	0	6	8	7	6	7	5	0	3	-	-	-	-	-	-
7.	10	8	10	8	9	5	6	10	5	7	8	8	7	8	5	8	-	-	-	-
8.	5	9	6	3	0	3	0	5	7	10	8	9	6	1	0	2	-	-	-	-
9.	9	10	10	7	8	10	10	11	10	9	12	12	13	9	8	12	10	12	9	9
10.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-
11.	12	12	12	10	11	11	10	11	10	12	12	13	-	-	-	-	-	-	-	-
Total	70	63	69	54	66	65	66	78	72	73	78	77	58	49	42	42	41	41	36	38
Average	6.4	5.7	6.3	4.9	6.0	5.9	6.0	7.1	6.5	6.6	7.1	7.0	5.8	4.9	7.0	7.0	8.2	8.2	7.2	7.6
<i>After Administration</i>																				
1.	13	12	12	11	10	8	8	0	5	12	12	12	12	12	11	12	11	13	12	11
2.	10	9	11	11	13	12	12	12	11	0	0	0	0	0	12	12	11	9	0	0
3.	5	9	6	10	9	9	9	11	10	10	9	10	9	8	2	5	10	10	11	11
4.	14	10	11	10	12	11	12	12	12	12	11	11	12	11	12	12	12	10	11	11
5.	13	0	3	13	8	13	11	12	12	12	12	5	11	12	12	12	12	10	11	11
6.	13	13	11	11	7	8	8	9	9	11	11	10	9	9	9	11	11	8	10	11
7.	12	10	10	10	10	8	9	3	7	9	10	10	9	7	4	5	5	7	10	-
8.	11	10	11	10	7	12	7	6	0	7	8	13	13	10	9	10	7	5	3	9
9.	12	12	12	12	12	12	12	12	12	12	12	12	12	13	13	12	12	12	12	12
10.	6	10	9	4	0	0	0	0	3	8	12	10	8	5	10	10	8	4	7	-
11.	12	12	12	12	13	12	13	13	12	13	12	12	12	12	12	12	-	-	-	-
Total	119	107	108	114	101	105	101	90	93	106	109	105	107	99	106	113	99	89	76	64
Average	10.8	9.7	9.8	10.4	9.2	9.5	9.2	8.2	8.5	9.6	9.9	9.5	9.7	9.0	9.6	10.3	9.9	8.9	8.4	9.1

study except that a 10 per cent solution of dextrose in sterile water was administered in place of saline solution. Our findings indicate a slight increase in the rate of activity in the segment following the onset of drip phleboeclysis with the dextrose solution (Graph 2). The increase in rate showed no definite change or tendency to decrease in the twenty-minute interval during which the segment was being observed. The amount of increase was not nearly as marked as noted with the saline solution used in the previous experiment, and is small enough to come within the scope of experimental error. On the other hand, depression is at least atypical.



The impression obtained from this series of experiments was that stimulation of intestinal motility was produced in the majority of instances. This, however, was so slight as to be inconclusive. In Experiments 10 and 7 (Table II) with the segment contracting at a maximum rate, no consistent depression of activity following the dextrose injection could be demonstrated. In Experiment 5 a definite stimulation of activity can be easily observed. On the other hand, in Experiment 6 the injection of glucose was inadequate to start activity in a quiet segment. To prove that the segment was not passive to stimulation, following the failure of the dextrose solution, 2 c.c. of a 15 per cent solution of sodium chloride were injected intravenously. Vigorous, forceful peristaltic contractions at a maximal rate began almost immediately. In Experiment 5 contractions following dextrose were much increased in force; in Experiment 4, conversely, the contractions were found to remain weak even after the dextrose solution had been administered.

working with isolated guinea pig intestine, found that a 0.1 per cent dextrose solution produced a definite as well as marked increase in both tonus and amplitude of peristaltic contractions, this effect lasting from seven to eight hours. Several other sugars were studied by these same investigators in a rather complete and detailed study. Strips of intestine were suspended in a warm tyrode solution to which the substances studied were added. Dextrose called forth increased activity as did mannose. Galactose, when added to the solution, had no effect.

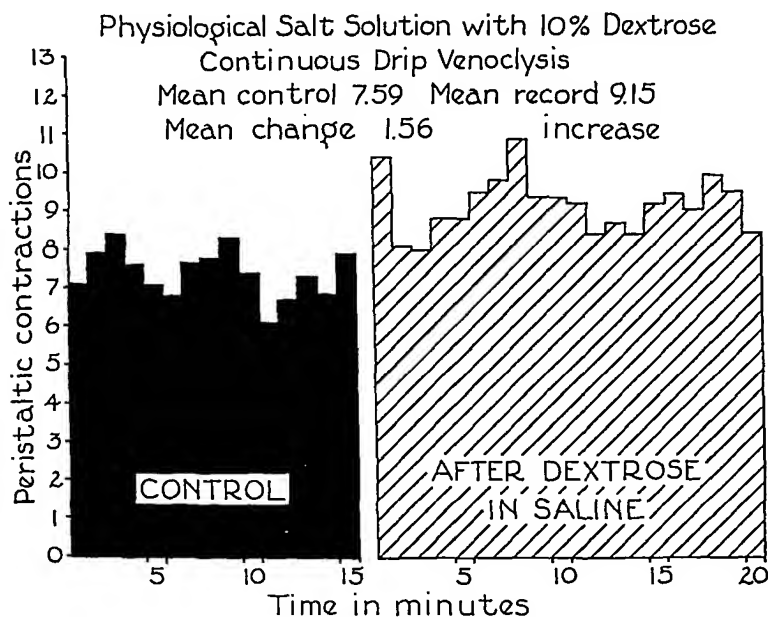
A similar confirmatory piece of work was done by Pal and Prasad (1935) who concluded that a concentration of 0.1 per cent represented an optimum. Isolated rabbit gut was used in this instance with a technique similar to that of Neukirch and Rona. No effects were noted when glucose was added up to a concentration of 2 per cent. It was assumed by them, therefore, that the 0.1 per cent of dextrose already contained within the tyrode solution was an optimum concentration.

Gage, Ochsner, and Cutting (1931-1933) reported a depression in activity of both normal and obstructed bowel following dextrose solution by vein. Their work was done upon dogs in which enterostomies had been prepared. An ingenious procedure was devised by which it was possible to cause an obstruction of the bowel at will. In this way they studied the effects on both the normal and the obstructed bowel. They found inhibition of intestinal activity to follow the intravenous administration of dextrose in every one of their cases. However, they could find no correlation between blood sugar level and intestinal activity.

Quigley and Hallaran observed the effects of intravenous dextrose solution upon the stomach, terminal ileum, and colon by the multiple balloon method. No modification in activity was reported, but the absence of any inhibition was especially commented upon. In a succeeding supplementary work, Quigley and Highstone (1934) again could find no marked changes in the rate of intestinal activity except when hypertonic solutions were used. They found that hypertonic solutions of dextrose by vein definitely augmented the propulsion rate through a loop of dog jejunum, thereby confirming the findings of Hughson and Searff. This work was done using the bolus method and noting the time necessary for it to traverse a loop of dog jejunum. An increase in activity was assumed if there was a decrease in the time necessary for the bolus to traverse the intestinal loop. By this means they decided that an increased propulsion time was atypical and decided from this that dextrose was not contraindicated in the therapy of ileus. The work of Hughson and Searff on dextrose was reported only superficially in their paper on saline solution.

Experimental Findings.—The method and technique employed in this series of eleven experiments were identical to those used in the previous

In analyzing this series of experiments one finds three instances of a more or less marked depression in activity in Experiments 4, 8 and 11. Experiments 6 and 7 show no marked change from the control, which is especially significant in Experiment 6 where the control observation revealed no activity because it demonstrates a failure to instigate any peristalsis. The remaining six studies all indicate some measure of stimulation following the venoclysis. The exact amount of stimulation varies in each individual case.



Graph 3.

PHYSIOLOGIC SALINE SOLUTION WITH TEN PER CENT DEXTROSE

Although solutions of dextrose in physiologic saline solution are quite extensively used intravenously in many medical and surgical diseases, there has been little experimental work done relative to the effect on peristaltic activity of this combination. The papers written have concerned themselves with sodium chloride and dextrose independently and, as such, have been discussed above. As this combination is so widely used, it was felt advisable to include it in this study. The technique and methods employed were identical with those followed in the two previous groups of studies. Administration of 10 per cent dextrose in physiologic saline solution was made into the external saphenous vein by drip phlebotomy. The observations indicate a definite increase in the rate of activity following the onset of the infusion, but not as marked as was noted following the use of physiologic saline solution alone (Graph 3;

TABLE II
TEN PER CENT DEXTROSE SOLUTION

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Before Administration</i>																				
1.	7	4	5	3	3	7	10	9	8	11	12	8	4	11	8					
2.	7	10	6	6	12	12	9	9	8	8	10	10	7	7	6					
3.	12	9	5	8	11	10	12	5	2	6	3	8	13	6	7					
4.	11	5	1	6	13	12	8	4	6	5	9	8	7	6	9					
5.	1	12	6	11	8	7	11	5	5	7	4	4	4	8	6					
6.	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
7.	12	12	8	12	11	11	12	11	7	11	10	10	11	9	5					
8.	12	12	11	11	11	11	11	3	5	9	8	4	9	10	9					
9.	6	8	0	6	7	6	8	0	8	1	3	5	4	9	2					
10.	12	11	12	12	11	8	5	6	10	9	7	12	12	12	12					
11.	0	0	2	8	12	11	10	10	10	10	12	8	9	3	5					
Total	80	83	56	83	99	96	97	62	69	77	77	77	80	81	69					
Average	7.3	7.6	5.1	7.6	9.0	8.8	8.8	5.6	6.3	7.0	7.0	7.0	7.3	7.4	6.3					
<i>After Administration</i>																				
1.	12	8	2	13	10	9	10	11	11	11	10	12	9	8	11	11	8	9	11	11
2.	12	12	12	11	9	6	5	9	7	8	5	3	9	2	8	9	8	7	3	2
3.	12	12	11	10	5	2	10	11	13	12	7	6	1	4	7	8	7	7	7	6
4.	3	6	5	5	6	3	6	3	3	4	4	5	4	4	6	1	3	4	8	8
5.	12	11	12	12	13	13	13	10	11	12	12	12	13	12	12	11	10	10	10	12
6.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	11	10	12	12	12	12	10	9	12	12	11	11	10	9	10	7	9	10	9	7
8.	13	8	10	5	8	4	5	6	4	10	9	10	10	9	8	9	8	6	6	10
9.	4	4	3	2	5	8	7	11	10	11	9	10	2	4	7	10	13	12	11	7
10.	12	14	14	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12
11.	0	1	8	6	8	4	5	5	6	5	4	5	8	4	3	4	4	5	7	6
Total	93	86	88	88	88	72	83	87	89	97	84	86	78	68	84	83	83	82	84	81
Average	8.4	7.8	8.0	8.0	8.0	6.5	7.6	7.9	8.1	8.9	7.6	7.8	7.1	6.2	7.6	7.6	7.6	7.5	7.6	7.4

TABLE III
TEN PER CENT DEXTROSE IN PHYSIOLOGIC SALINE SOLUTION

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Before Administration</i>																				
1.	0	0	0	3	2	9	5	5	14	9	3	2	0	0	2					
2.	4	13	12	10	10	12	6	10	11	10	9	9	4	7	11					
3.	12	12	12	12	11	11	11	6	4	4	0	2	2	0	3					
4.	10	10	10	9	8	5	5	4	9	5	7	7	10	10	12					
5.	8	4	8	4	8	5	6	7	6	7	11	6	13	8	8					
6.	12	12	12	12	12	12	12	11	11	12	11	12	12	12	12					
7.	0	3	5	0	3	0	2	2	6	0	0	1	5	9	1					
8.	7	9	8	6	8	0	6	12	6	9	7	8	6	6	11					
9.	1	4	1	2	4	5	10	9	3	9	6	12	9	7	11					
10.	11	7	12	12	0	0	11	12	7	4	0	2	8	4	3					
11.	13	13	12	13	13	13	13	14	12	12	13	12	13	11	13					
Total	78	87	92	83	78	75	85	97	81	81	67	73	79	74	87					
Average	7.1	7.9	8.4	7.6	7.1	6.8	7.7	7.8	8.3	7.4	6.1	6.7	7.3	6.8	7.9					
<i>After Administration</i>																				
1.	9	1	6	11	1	3	4	1	3	4	3	3	10	7	7	16	14	13	12	10
2.	11	10	11	10	9	9	11	13	12	11	11	10	11	12	12	11	11	12	12	11
3.	4	4	3	5	4	9	7	10	12	6	5	10	1	10	5	6	2	4	3	3
4.	11	12	12	11	11	12	12	12	11	11	12	12	12	12	12	11	12	12	12	12
5.	12	8	7	8	12	13	13	13	14	13	13	12	13	13	13	13	12	12	13	13
6.	12	11	12	12	11	9	10	11	9	10	11	11	8	5	9	9	9	10	12	10
7.	13	4	0	0	8	10	2	11	1	4	2	0	0	0	4	9	7	8	1	1
8.	11	10	8	10	10	12	12	12	12	10	10	13	7	8	10	7	9	9	9	12
9.	12	12	13	13	13	13	13	13	12	13	13	13	12	11	12	11	11	12	12	11
10.	6	4	3	4	4	4	11	11	3	9	10	2	10	10	7	1	2	11	12	1
11.	14	13	13	12	14	12	13	12	13	11	11	12	11	3	10	9	10	6	6	8
Total	115	89	88	96	97	104	108	119	102	102	101	92	95	92	101	103	99	109	104	92
Average	10.4	8.1	8.0	8.8	8.8	9.5	9.8	10.8	9.3	9.3	9.2	8.4	8.7	8.4	9.2	9.4	9.0	9.9	9.5	8.4

Here again, a survey of the individual studies reveals that a majority show stimulation (Table III). Depression in activity was found only in two instances, Experiments 3 and 6, and in the latter it was neither marked nor complete. In both Experiments 10 and 11 the changes were so slight as to be of little importance except for the demonstration in Experiment 11 that no definite or consistent inhibition is produced in an active segment. The remaining seven experiments all showed varying degrees of stimulation following venoclysis. In general, stimulation of activity of the segment, both in rate and force of peristaltic contractions, was marked and consistent enough to permit the conclusion that this combination of dextrose and saline solutions possesses definite enterokinetic properties.

The question of strength of contractions in the preceding experiments was necessarily a subjective observation. This factor, however, could be fairly accurately judged by the depth of the contraction rings, the clearness of their definition, and the amount of local ischemia produced by them. In the majority of instances there appeared to be a definite relationship between optimal contraction strength and maximal peristaltic rate. Variations in this relationship were atypical.

INSULIN

Literature Review.—Winter and Smith (1924) studied strips of small intestine which were suspended in warm oxygenated Ringer's solution. The addition of insulin to the solution produced a diminution in amplitude of the peristaltic contractions and often was accompanied by a diminution in tonus. They felt that insulin acted upon the nerve cells and/or their endings rather than upon the muscle. Mulinos (1933) wrote that insulin hypoglycemia is accompanied by gastric hypermotility which is counteracted by glucose, but that the intravenous injection of insulin resulted in a temporary depression in the normal activity of both the stomach and ileum. Meythaler and Graeser (1933) studied the effect of insulin on the gut of the guinea pig. The insulin used was a phenol-free product, and the readings were made by means of a tube fastened to the gut and to a water manometer. Injections, made directly into the muscle of the middle and lower portion of the small gut, produced an increased rest period. In one case there was an alteration in rhythm. Intravenous injection was made directly into the heart and was followed by a similar increase in the rest periods between contractions. A temporary loss of tonus lasting from one to four minutes was commented upon also. In only one case was any increase in activity of the gastrointestinal tract noted, and that was a stimulation in activity of colon contractions. Prasad (1934) found that insulin would lessen the amplitude of contractions of an isolated strip of intestinal muscle. The tonus was also noted to be somewhat affected, although the rate of movement was little altered.

minute periods beginning ten, thirty and sixty minutes after the injection. Seven similar studies comprised this series. The final experiment consisted of ten observations in which, following the control period, the influence upon intestinal motility of 10 per cent dextrose solution containing ten units of insulin per 100 c.c. was studied. This solution was administered by drip venoclysis at 5 c.c. per minute. Thus, in each twenty-minute observation period, the dog received 10 gm. of dextrose and ten units of insulin. Commercial insulin was used to conform to that generally used in clinical practice.

Following nearly every administration of commercial insulin, whether injected subcutaneously or intravenously, there was a decrease in intestinal motility. This was more apparent in the diminution of intestinal tonus and the strength of contractions than in retardation of peristaltic rate. The findings were most pronounced when insulin alone was administered. In this group of experiments there was a markedly uniform decrease in tonus and muscular power as well as a reduction in rate (Graph 4). A majority of observations showed a progressive diminution in rate which was most marked sixty minutes after the administration of insulin.

The combination of dextrose and insulin in the majority of instances appeared to have a slight but progressively depressing effect upon the bowel (Graph 5, Table V). Here again the loss of tonus and the decrease in the force of the peristaltic contractions were more noticeable than was the alteration in rate. During the first few minutes of the infusion, the rate was slightly accelerated but soon decreased to an average below that of the control.

DISCUSSION

Disturbances of gastrointestinal motility are responsible for much postoperative pain and discomfort as well as interference with assimilation of food and fluids. Many factors contribute to this interference, including manipulation of the intestines during surgical procedures, early administration of oral feedings, and the effects of drugs and anesthesia. To avoid unnecessary distress, it is important to understand the influence on intestinal motility of the therapeutic agents employed. Intravenous infusion has proved to be of great value in maintaining fluid balance and nutrition until oral administration can be tolerated. Studies of the influence upon peristalsis and bowel tonus of various fluids employed are, therefore, important. Many such studies have been made, but the results are not in accord.

The preparations used in these studies permitted direct visualization of segments of small intestine in dogs. Previous studies on similarly prepared animals have established the type of motility seen under normal physiologic conditions.²¹ The survival nature of the animals permits repeated observations which are not influenced by anesthesia or

Like Winter and Smith, Abderhalden and Gellhorn (1925) found that commercial insulin produced a decrease in the tone and automaticity of the bowel. They presumed that such an effect might be due to the phenol used as a preservative in the commercial product and so repeated their experiments using a phenol-free insulin. The pure insulin produced depression in the activity of the gut which was followed by a period of increased tonus and greater contractions. The work was done upon the small bowel of the rat and the colon of the guinea pig. A rather complete study of the response of both heart and intestine to insulin was made by Barlow (1931). Isolated rabbit intestines suspended in oxygenated Locke's solution were studied. The addition of insulin to this solution produced a brief depression lasting for two to twelve minutes, followed by a more lasting stimulation. In general, these results are comparable to those of Winter and Smith. With repeated doses they found a distinct increase in the rhythmic activity of the section of bowel. The initial reaction was felt to be like a weak epinephrine response; that is, a stimulation of the inhibitory sympathetic receptive mechanism; whereas, the secondary improvement in tone and activity was supposed to be due to a stimulating effect that was purely muscular in its site of action.

Quigley and Solomon (1930) in studies upon dogs and man found that insulin produced an increase in colonic activity which was noted to be closely parallel to gastric activity. By means of a duodenal tube they were able to ascertain that there was also an increase in the duodenal activity of man. Gage, Ochsner, and Cutting (1931 and 1933) in two papers on the effects of insulin and dextrose on the normal and obstructed bowel reported a distinct improvement in activity following the use of insulin. They felt that such a reaction counteracted a depression in activity that was noted subsequent to intravenous dextrose medication. They concluded that it would be desirable to give insulin routinely whenever dextrose is given postoperatively to obviate any tendency to ileus. Pavel and Milecu (1932) found that in the majority of instances insulin augmented the activity of the gut. The stimulation also occurred after section of the vagus nerve, and they suggested that the parasympathetic nerve endings were the site of action. They did note an inhibitory response in a certain number of cases. Krishnan (1934) noticed only a stimulating effect of insulin and felt that his work confirmed that of Quigley and co-workers. He could find no response of isolated bowel to insulin.

Experimental Findings.—Experimental procedures with insulin were fundamentally the same as those employed in the foregoing observations. The procedure was varied slightly in those studies in which the action of subcutaneous insulin alone was investigated. Following a fifteen-minute control period observations were made for three ten-

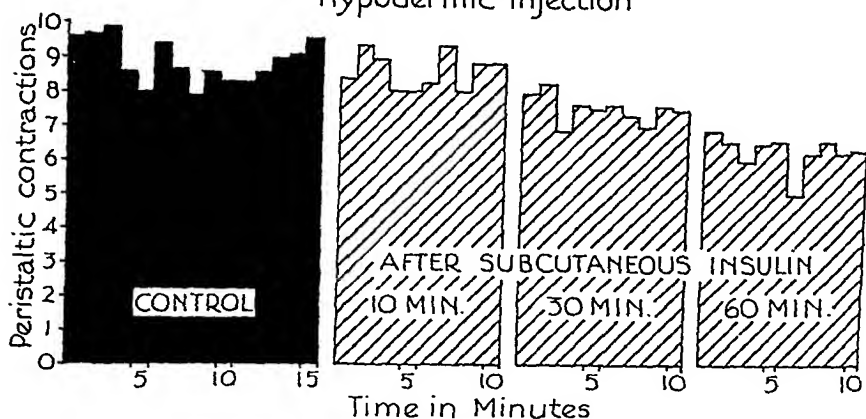
TABLE IV
INSULIN, TEN UNITS SUBCUTANEOUSLY

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<i>Before Administration</i>															
1.	0	3	4	2	2	4	2	1	2	3	1	4	3	4	5
2.	10	10	9	9	9	9	9	9	9	9	10	10	10	10	10
3.	14	13	13	13	12	13	13	12	13	13	13	13	13	12	13
4.	10	12	12	9	10	11	11	10	12	12	11	12	10	10	12
5.	11	10	10	10	10	10	10	10	11	9	9	10	10	10	10
6.	12	10	11	12	8	10	10	8	8	6	5	4	8	10	10
7.	10	10	10	5	5	9	6	5	5	6	9	7	9	8	7
Total	67	68	69	60	56	66	61	55	60	58	58	60	63	64	67
Average	9.6	9.7	9.9	8.6	8.0	9.4	8.7	7.9	8.6	8.3	8.3	8.6	9.0	9.1	9.6
<i>Ten Minutes After Administration</i>															
1.	2	3	2	4	3	3	3	1	5	4					
2.	5	6	8	8	6	8	8	10	8	7					
3.	11	12	12	12	12	12	12	11	12	12					
4.	10	12	12	10	11	12	12	11	12	12					
5.	9	8	5	4	7	7	9	6	7	3					
6.	12	13	12	11	12	12	12	11	12	12					
7.	10	12	12	8	6	4	10	8	6	12					
Total	59	66	63	57	57	58	66	58	62	62					
Average	8.4	9.4	9.0	8.1	8.1	8.3	9.4	8.3	8.9	8.9					
<i>Thirty Minutes After Administration</i>															
1.	6	5	4	6	4	5	6	4	6	6					
2.	7	10	5	7	9	7	9	9	6	8					
3.	11	12	11	11	11	12	10	10	12	11					
4.	10	10	9	10	10	10	11	11	11	11					
5.	9	5	4	5	7	7	5	4	4	3					
6.	9	10	8	9	8	9	8	8	10	8					
7.	4	6	7	6	4	4	3	4	5	6					
Total	56	58	48	54	53	54	52	50	54	53					
Average	8.0	8.3	6.9	7.7	7.6	7.7	7.4	7.1	7.7	7.6					
<i>Sixty Minutes After Administration</i>															
1.	3	1	0	1	4	3	3	1	2	2					
2.	9	8	8	8	8	8	8	9	10	9					
3.	8	9	8	9	8	8	7	8	7	8					
4.	9	9	7	9	7	8	8	9	8	9					
5.	4	3	4	3	4	2	3	4	2	2					
6.	9	9	9	10	9	8	8	7	8	8					
7.	7	8	7	6	7	7	7	9	7	7					
Total	49	47	43	46	47	36	44	47	44	45					
Average	7.0	6.7	6.1	6.6	6.7	5.1	6.3	6.7	6.3	6.4					

tributed to physiologic saline solution by some observers but denied by others. Under the experimental conditions here used physiologic saline solution increased the peristaltic rate and muscle tone of the small bowel. The results obtained when using 10 per cent dextrose solution intravenously suggest that this solution has very little effect upon small bowel action and its use should not encourage postoperative distension or bowel atony. When dextrose was combined with physiologic saline solution,

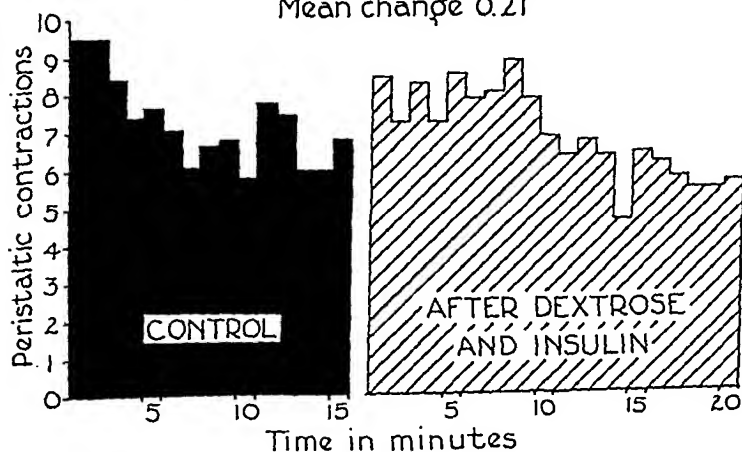
operative trauma. Interrupted continuity of the bowel and its abnormal location apparently have not altered the motility responses. As these studies were carried out in dogs, similar results in other animals and man can only be conjectured. Only the immediate effects of the intravenous infusions were noted and prolonged results or subsequent changes were not determined.

Commercial Insulin Units 10
Hypodermic Injection



Graph 4.

Ten percent Dextrose & Insulin
Units 10 in Solution - Venoclysis
Mean control 7.27 Mean record 6.96
Mean change 0.21



Graph 5.

Hypertonic saline solution administered by venoclysis has been generally recognized to be a stimulant to small intestinal motility and has been proved to be of clinical value in encouraging peristalsis and increasing intestinal tonus. Similar stimulating properties have been at-

peristalsis was mildly stimulated, but to a lesser degree than by the saline solution alone. This combination, therefore, should be of clinical value in encouraging active peristalsis.

Experimental observations on the effect of insulin upon intestinal motility have varied, some showing a definite inhibition, others a primary inhibition followed by stimulation, and still others showing only stimulation. Under the experimental conditions employed in these observations, the administration of commercial insulin subcutaneously or intravenously in combination with 10 per cent dextrose was followed by a diminution in intestinal tonus and strength of contractions and a slight reduction in peristaltic rate.

SUMMARY

In a series of survival experiments on dogs, motility was studied in isolated intestinal transplants. The influence of intravenous solutions commonly used in surgery and of insulin upon peristaltic rate and intestinal tonus was observed.

Physiologic saline solution administered by drip phlebotomy produced a definite increase in rate and strength of peristaltic contractions.

Ten per cent dextrose solution had very little if any effect upon small bowel motility.

Ten per cent dextrose in physiologic saline solution had a greater stimulating action upon peristalsis than did dextrose alone, but less than physiologic saline solution.

Insulin subcutaneously caused a progressive diminution of peristaltic rate and strength and of intestinal tonus. When insulin was administered intravenously combined with 10 per cent dextrose, the same inhibiting action was noted though the change in rate of peristalsis was very slight.

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TABLE V
INSULIN TEN UNITS AND GLUCOSE 10 PER CENT INTRAVENOUSLY

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Before Administration</i>																				
1.	14	12	11	7	6	0	0	6	1	0	6	10	8	2	2					
2.	10	10	10	10	10	10	10	10	10	9	12	12	11	13	12					
3.	12	12	7	1	12	7	8	12	5	5	12	12	3	3	8					
4.	5	4	4	7	6	4	3	6	10	8	8	1	10	10	11					
5.	9	8	7	7	7	6	4	4	6	5	5	3	1	6	2					
6.	10	11	8	3	2	10	11	7	3	7	7	9	4	4	8					
7.	12	12	12	13	12	10	12	11	10	12	12	11	12	13	12					
8.	2	6	6	6	4	6	2	3	2	5	2	6	2	2	2					
9.	11	12	11	12	11	10	2	0	1	0	5	3	0	0	1					
10.	10	8	8	8	7	8	9	8	10	7	9	8	9	7	10					
Total	95	95	84	74	77	71	61	67	68	58	78	75	60	60	68					
Average	9.5	9.5	8.4	7.4	7.7	7.1	6.1	6.7	6.8	5.8	7.8	7.5	6.0	6.0	6.8					
<i>After Administration</i>																				
1.	5	4	6	9	13	13	12	13	2	1	0	0	0	0	0	0	0	0	0	0
2.	10	12	12	12	12	12	12	12	12	13	11	10	12	9	6	10	8	9	8	8
3.	12	12	12	4	7	8	10	6	6	12	4	7	12	4	10	9	6	5	7	8
4.	8	5	5	4	7	8	9	9	11	10	7	8	8	5	9	6	8	3	4	2
5.	3	1	10	12	8	3	1	12	6	3	8	9	1	0	3	10	5	12	6	10
6.	7	10	10	10	8	8	12	9	13	8	9	6	10	4	10	8	10	7	8	8
7.	12	12	11	12	12	11	11	12	11	12	12	12	11	12	13	11	10	10	11	10
8.	8	6	6	4	6	4	4	6	6	4	3	6	4	6	6	5	4	6	4	8
9.	10	1	2	0	2	2	0	2	6	0	6	2	0	0	3	0	5	0	4	0
10.	10	10	9	6	11	10	10	6	6	6	4	8	6	7	5	3	2	3	3	3
Total	85	73	83	73	86	79	81	89	79	69	64	68	64	47	65	62	58	55	55	57
Average	8.5	7.3	8.3	7.3	8.6	7.9	8.1	8.9	7.9	6.9	6.4	6.8	6.4	4.7	6.5	6.2	5.8	5.5	5.5	5.7

GASTRIC PERISTALSIS

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THE COMMONLY accepted view of gastric peristalsis is that it is a function of the entire stomach wall. Forsell,³ many years ago, advanced the idea that the muscularis mucosa of the gastrointestinal tract was capable alone of producing movement in the mucosa. More recently, Cole² has stated that peristalsis in the stomach is a function of the muscularis mucosa. To those accustomed to see occasional peristaltic waves in the stomachs of patients undergoing laparotomy, this idea is somewhat startling.

This belief, however, is based on several observations. Probably the most important point has to do with the thickness of the gastric wall. Cole² pointed out that if all coats were involved in the constricting rings progressing towards the pylorus the thickness at the base of the wave should be twice that of the stomach wall; i.e., $\frac{3}{4}$ inch; yet this measurement averaged only between $\frac{3}{16}$ inch and $\frac{1}{16}$ inch. Thus, it is impossible for the wave to involve all the coats of the stomach. Other arguments in favor of this thesis are: (1) No sulcus angularis is to be seen in the stomach wall when the stomach is opened. (2) The mucosal coat is greater on the lesser curve than the length of the regular muscle coat. (3) Ulcers involving only the mucosa ride with the wave. Cole² concludes that hydrostatic pressure is carried by the muscularis propria and that the chyme is moved by the muscularis mucosa.

At the instigation of the late Dr. Howard Dickson, studies of gastric motility were undertaken in an attempt to prove the correctness, or otherwise, of this statement regarding the part played by the muscularis mucosa in gastric peristalsis.

Histologically the stomach wall is composed of six coats, mucosa, muscularis mucosa, submucosa, muscularis propria (two layers), and the serosa. A very intimate connection exists between the first two. Prolongations of the muscularis mucosa can be traced readily among the tubules of the mucosa. The submucosa is a lax structure composed of branching fibrous tissue and capable of extending transversely, after the manner of a telephone extension bracket; i.e., allowing the two inner layers to separate relatively widely from the outer three. The longitudinal and circular muscle coats and the serosa are closely connected and in the gross can be easily dissected from the inner two. Thus, we

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placed in the stomach through a lavage tube. Radiologic examination was then done. This proved an unsatisfactory method, the wires being too stiff.

Accordingly, a second group of experiments was performed in which individual lead beads were sewed at intervals along the two curvatures of the stomach. It was quite evident on fluoroscopic examination of these animals, after barium had been placed in the stomach, that peristaltic waves passed distally without disturbing the alignment of the beads. This was always true when the waves were of moderate depth. When marked waves were present, a ripple was reflected in the line of the beads. Radiographs were not as convincing as the fluoroscopic examination, partly because it was impossible to place the plane of the two rows



Fig. 3.—The distal half of a dog's stomach was denuded of muscularis propria except for a strip one-half inch wide along the lesser curvature. The operation was done three months prior to giving the barium meal. Peristalsis was very shallow in the denuded portion of the stomach and disappeared entirely in the extreme pyloric end. This denotes that good peristalsis of muscularis mucosae requires the supporting action of the muscularis propria. These findings were noted in six dogs.

of beads parallel to the plane of the cassette and partly because it was difficult to keep the animal still. No sedatives or stimulants were used during the examinations. However, study of these plates revealed that, in addition to the movement described, changes occurred in the relation of the beads to each other and in the relation of one row of beads to the other. Thus, as the peristaltic wave passed along the muscularis mucosa, tonic changes were occurring in the muscularis propria. (Fig. 1.)

In the third group of experiments, the serosa and muscularis propria were divided at the level of the incisura. This division completely en-

have histologic and gross evidence that it is possible for the mucosa and muscularis mucosa to move freely on the outer three coats, the movement being possible because of the laxness of the submucosa.

The first group of experiments consisted in sewing fine, flexible wire along the greater and lesser curves in the pyloric region of dogs' stomachs. When the dogs had fully recovered, a barium meal was

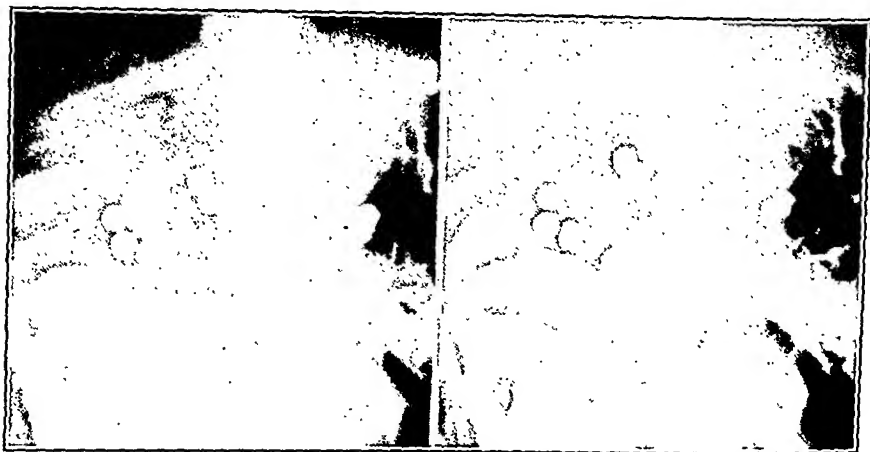


Fig. 1.—The heavy metal beads fixed to the serous coat on the greater and lesser curvatures of the stomach mark the position of the muscularis propria. It is noted that the position of the beads as seen in A, with the pylorus distended with barium, remains unchanged in B, when this portion of the stomach contracts. This would indicate that here the muscularis propria has not contracted in peristalsis and that the contraction is due to peristalsis in the muscularis mucosa. Similar findings were noted in nine other dogs.



Fig. 2.—In this experiment the serosa and muscularis propria previously had been divided approximately at the incisura angularis. Comparison of the pyloric end of the stomach seen in A and B shows good peristalsis three weeks after operation. The short interval precludes the possibility of nerve regeneration distal to the line of section. These findings were noted in six dogs.

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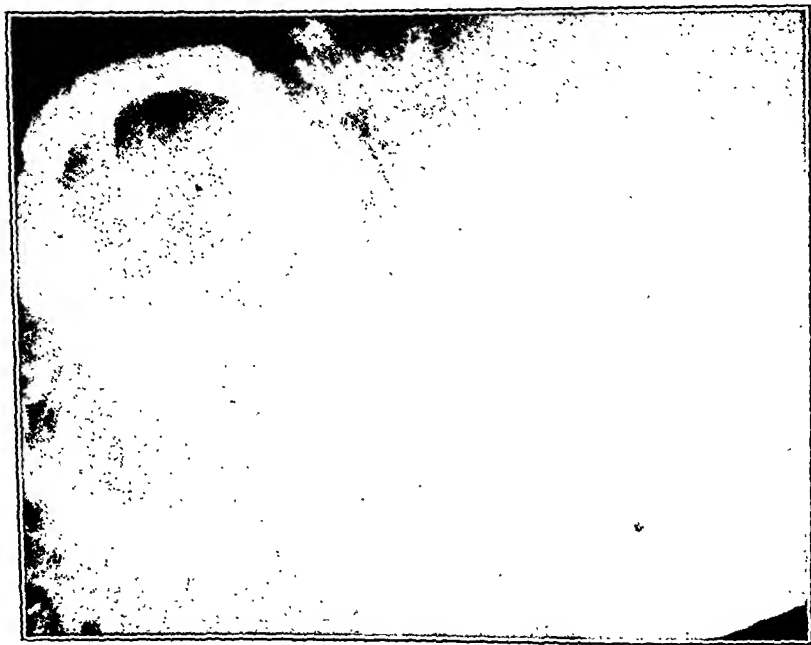


Fig. 3.—The distal half of a dog's stomach was denuded of muscularis propria except for a strip one-half inch wide along the lesser curvature. The operation was done three months prior to giving the barium meal. Peristalsis was very shallow in the denuded portion of the stomach and disappeared entirely in the extreme pyloric end. This denotes that good peristalsis of muscularis mucosae requires the supporting action of the muscularis propria. These findings were noted in six dogs.

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circled the stomach except for one-half inch on the lesser curve. The incision was immediately sutured, in one-half the cases cellophane being interposed between the ends of the muscle. Beads were placed as before. Three weeks later fluoroscopic examination showed normal looking peristaltic waves passing to the pylorus and which involved the mucosa and muscularis mucosa only (Fig. 2).



Fig. 4.—In this case small metal beads were fixed to the serous coat of the stomach along the greater curvature. As the serous coat is intimately attached to muscularis propria, the beads indicate the position of this muscle layer. It will be seen that the beads remain in the same relative position, while the barium shadow changes, due to peristalsis of the muscularis mucosae. Eleven other dogs gave similar findings.



Fig. 5.—Here again small metal beads have been introduced to indicate the line of the muscularis propria. Note the change in the barium shadow in the pyloric antrum without disturbance in the position of the beads.

The next experiment consisted in denuding the distal one-half of the stomach of its serosa and muscularis propria. This was done completely with the exception of a narrow strip along the lesser curve. Subsequent radiologic examination failed to reveal any but the very shallowest of

peristaltic waves in this denuded portion. Invariably they faded out before reaching the pylorus. Nevertheless, the dogs treated remained healthy and fat. One, which lived for fourteen months, died of a perforated gastric ulcer in the denuded portion (Fig. 3).

Finally, to overcome any objection which might lie in the weight of the lead beads, fine steel beads were sewed onto the greater and lesser curves, or in some instances to the greater curvature only, and x-ray studies were made. Again normal peristaltic waves were seen to pass distally along the stomach without involving the muscularis propria. Occasionally, however, vigorous broad waves which took in all coats of the stomach were noted. (Figs. 4 and 5.) Similar results were obtained by the use of metal clips such as are used in neurosurgery (Fig. 6).



Fig. 6.—In this experiment small metal clips were fixed to the serosa of the stomach on the greater and lesser curvatures. In *A* the pair of clips closest to the pyloric sphincter, as measured on the original film, were 2.5 cm. apart and the barium shadow 1.9 cm. wide. On peristaltic contraction (*B*), the clips were 1.9 cm. apart, while the barium shadow was reduced to 0.7 cm. The major part, at least, of the contraction must be due to peristalsis of muscularis mucosa.

DISCUSSION

Thus it would appear that there are two types of peristaltic waves normally present in the stomach. The vigorous type involving all coats of the stomach has been noted by everyone doing abdominal surgery and was seen in the last group of experiments. In addition, there is a second type which involves mucosa and muscularis mucosa only.

The functions of this wave can only be conjectured. Suggested functions are propulsion and mixing of stomach contents. In addition, it brings a greater area of mucous membrane into relation with the bolus of food. To function properly, the bolstering action of the muscularis propria is required.

CONCLUSIONS

1. There are two types of gastric peristalsis.
2. The first type involves all coats of the stomach wall, is probably purely propulsive, and is quite wide.
3. The second type involves only mucosa and muscularis mucosa and requires the presence of the outer three coats. Its function would appear to be propulsive and would also serve to mix stomach content.
4. As this second wave passes distally, tonic changes occur in the muscularis propria.

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NEUROGENIC FIBROMA OF THE TRANSVERSE COLON

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A CASE of neurogenic fibroma of the large intestine is reported as an example of a rare lesion. That such tumors are rare in the bowel is attested by a study of the literature. Buie and Swan, in 1929, reviewed the benign tumors of the large intestine and cited adenomas, adenofibromas, adenomyomas, fibromyomas, angiomas, polyps, and cystic tumors but made no mention of neurogenic fibromas in this region. Ochsner, in writing on the same subject, states only that "neurofibromas may occur in the intestinal tract without cutaneous lesions."

In 1917 King reported a subserous fibroma of the ascending colon. Hertaux, Bevan, Lange, and others have published similar cases. Ewing, in a discussion of visceral neurofibromatosis, states briefly that such tumors may occur at any point along the gastrointestinal tract from the lips to the anus. He quotes Sarazanas, who collected cases in which neurogenic tumors occurred in the tongue, stomach, jejunum, ileum, colon, vagina, and bladder. However, in a diligent search of the literature, no histologically proved case of neurogenic fibroma of the large intestine was found.

The neurofibroma to be described arose from the mesenteric portion of the transverse colon, and in this respect it coincided with the general characteristic of neuromas, that they originate from medullated nerve fibers. According to some pathologists such tumors arise from the sheath of Schwann. For a short time after their inception presumably they remain encased by the perineurium until they rupture through this structure. Thereafter, they probably grow as an expanding bud, without apparent involvement of the axon or myelin. They are circumscribed, encapsulated tumors, which in their growth encroach upon the lumen of the bowel by pushing its mucosa before them. Thus such a lesion may produce none of the signs and symptoms commonly associated with tumors of the large bowel and may be recognized only by the presence within the colon of a mass which causes pressure on adjacent structures, as upon the ureter in the case reported.

In 1938 the case of neurogenic fibroma of the transverse colon came under my care. The protocol of the case is as follows:

CASE REPORT

Mrs. H. R. (Hospital No. 216435), a woman 25 years of age, was admitted to the Urological Outpatient Department on Sept. 30, 1938, complaining of frequency

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of micturition and dysuria of two weeks' duration. Her family and her own past histories were unimportant. She had always been healthy. Two weeks before admission to the Clinic, she had frequency of micturition one night, followed the next day by terminal dysuria; the dysuria persisted for two days and then gradually subsided over a period of ten days.

The examination in the urological clinic revealed an abdominal tumor of which the patient had not been aware. Because of this tumor the patient was admitted to the surgical department of the hospital.

The patient's general physical condition was excellent. There was no evidence of loss of weight, pigmentation of the skin, or subcutaneous tumors. On physical examination nothing unusual was found except the abdominal tumor. About 5 cm. to the right of the umbilicus there was a readily palpable, round, nontender mass which moved slightly on respiration. (Fig. 1.) The tumor could be displaced in an orbit of 10 cm., but attempts to grasp it and carry it forward failed; therefore, it was assumed that it was fixed to the posterior abdominal wall or to some other firmly attached structure. There was no enlargement of the liver, and the spleen was not palpable. Pelvic and rectal examinations showed no abnormalities.

The laboratory examinations of the blood, urine, and stool showed nothing abnormal. X-rays of the chest gave no evidence of parenchymal or pleural infiltration. The heart was normal in size. Pyeloureterograms showed normal, well-outlined pelvis and calices of both kidneys. The ureters were clearly visible; the right ureter was seen to be displaced medially with some distortion by an extrinsic mass.

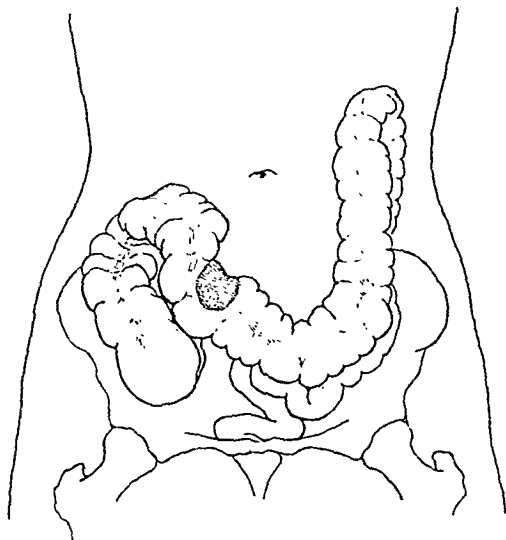


Fig. 1.—Schematic drawing of colon indicating position and size of tumor.

With a barium enema (Fig. 2), film and fluoroscopic examination of the large bowel gave evidence of complete filling except in the proximal portion of the transverse colon where there was a rounded defect about 4 cm. in diameter which corresponded in location to the mass palpated in the abdomen. Below this point the sigmoid was redundant. As the column of barium approached the lesion, it divided into two streams around the defect. It was apparent that the tumor lay inside the transverse colon, for it could not be separated from it. Air injections revealed obliteration of the intestinal pattern within the confines of the defect.

The general impression obtained was that the lesion was a tumor, probably a polyp, in the proximal portion of the transverse colon.

The patient was subjected to operation on Oct. 18, 1938. The abdominal cavity was approached through a mid-right rectus incision. It was found that the transverse colon was displaced downward and laterally so that its most dependent portion was in contact with the cecum. The ureter was seen to be out of position and medial to the tumor. The mass, when palpated within the bowel, was spherical, firm in consistency, and about 4 cm. in diameter. It apparently arose from the mesenteric portion of the intestine. The colon was dissected free from its peritoneal attachment and drawn into the wound. A section of colon, measuring about 12 cm. and including the tumor, was resected and continuity of the intestine was immediately re-established by aseptic end-to-end anastomosis in which mattress sutures of black silk were reinforced by interrupted sutures of the same material.

The patient had an uneventful recovery.



Fig. 2.—Photograph of roentgenogram showing displacement of barium by the tumor.

PATHOLOGICAL REPORT

The gross specimen (Fig. 3) consisted of a section of the proximal portion of the transverse colon approximately 12 cm. in length in which could be felt a firm, rounded tumor adherent to the mesenteric border. When the bowel was opened, the tumor was found to be covered with normal mucosa which was freely movable over it. The mucosa had been pushed into the lumen of the bowel by the tumor which arose from a deeper layer of the intestinal wall.

The microscopic sections of the tumor were prepared with the Masson trichrome method, a silver impregnation to demonstrate the reticulum and a block Cajal impregnation to demonstrate nerve fibrils. The Masson preparations showed a characteristic formation in which numerous interlacing bundles of tissue intersected each other in all directions, sometimes marking off enclosed bundles of transversely cut cells and fibers. The cells were large and stellate and varied in number in differ-

ent parts of the section. Some areas were quite cellular while others were chiefly fibrous. The reticulum impregnation showed a large number of reticular fibers which ran parallel to each other, delimiting empty spaces and resembling peripheral nerves in structure. In short, the fibrous arrangement of the tumor roughly imitated that of a peripheral nerve. The Cajal impregnation (Fig. 4) showed the cells of the tumor to

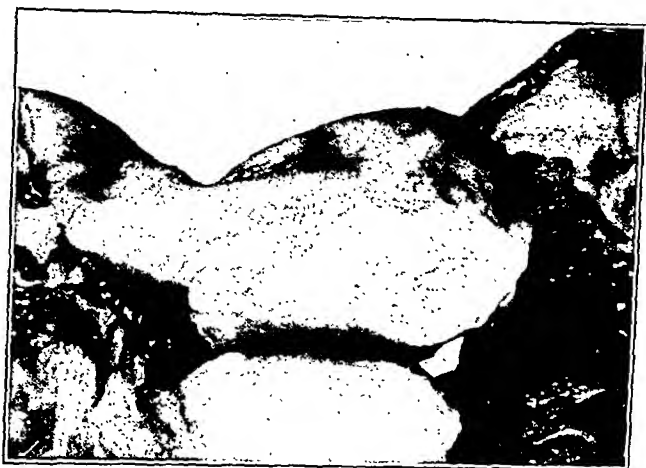


Fig. 3.—Neurogenic fibroma of the transverse colon. Photograph of specimen removed at operation.

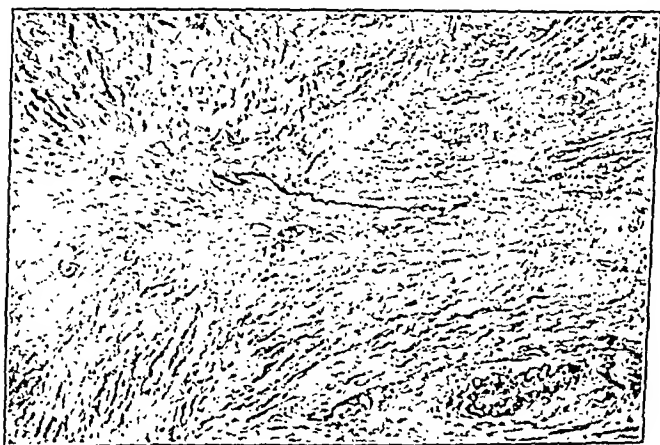


Fig. 4.—Photomicrograph, neurogenic fibroma of the transverse colon; a Cajal impregnation demonstrating a nonmedullated nerve fiber ($\times 150$).

be large, somewhat anastomotic, fusiform and stellate, resembling myoblasts or sheath cells. The actual demonstration of nerve fibers in the tissue was difficult for they were very sparse and often minute. Here and there they were fairly large and could be identified readily as non-medullated nerve fibers; in other places they were so delicate that one could not always be sure that they were not the edges of clefts in the

tissue which had taken the silver stain. It could readily be demonstrated, however, that the latter was not true in all instances. These fibers undoubtedly represented the small sympathetic fibers of the nerve sheath and did not constitute large axons. The tumor was, therefore, largely of a fibromyxomatous nature, presumably arising from a nerve trunk in the wall of the viscus. It showed no evidence of malignant degeneration.

The pathologic diagnosis was neurogenic fibroma of the hepatic flexure of the colon.

COMMENT

Foot,* in a paper on peripheral neurogenic tumors, emphasizes the point that in order to make a correct diagnosis of neurogenic tumors sections should be stained not with hematoxylin-eosin or eosin-methylene blue alone, but with the Masson trichrome aniline blue and silver impregnation methods. In the examination of different sections from any one block of tissue, he advocates the use of several stains to verify the first impression obtained before a final diagnosis is made. The neurogenic tumor described here is a good example of the advisability of using other than the routine methods of staining sections of doubtful tumors. It further illustrates the ease with which a nonobstructive benign intestinal tumor can be resected with the intestine surrounding it, the continuity of the bowel being immediately re-established by an end-to-end anastomosis.

SUMMARY

A neurogenic tumor of the transverse colon is described. The portion of the bowel enclosing the tumor was resected and an end-to-end anastomosis immediately performed. The patient made an uneventful recovery.

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*Description of tumor by N. C. Foot, Professor of Surgical Pathology, Cornell University Medical College.

NUTRITIONAL DISTURBANCES IN REGIONAL ENTERITIS

CASE REPORT AND DISCUSSION OF THE EFFECT OF THESE DISTURBANCES ON THE POSTOPERATIVE COURSE

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NUTRITIONAL disturbances similar to those observed in many medical conditions may occur in surgical practice. Not infrequently, however, they are overlooked or are overshadowed by the more important picture of the primary condition. These disturbances most commonly consist of malnutrition, avitaminosis, and depletion of the body proteins. Among the surgical diseases in which nutritional disturbances are found may be included the chronic gastrointestinal diseases, such as peptic ulcer; ulcerative colitis; pancreatic, biliary, or intestinal fistulas¹ (usually postoperative); prolonged drainage following intra-abdominal suppuration; chronic lung abscesses; severe burns; and prolonged drainage of septic joints. To this list we now may add regional enteritis. These nutritional disturbances may be due to one or more of the following factors: (1) diminished intake of food due to loss of appetite, nausea, vomiting, or dietary restriction; (2) lack of absorption of nutritive elements from the ingested food, because of alterations in the mucosa of the gastrointestinal tract; (3) severe and uncontrollable diarrhea; (4) loss of protein through profuse and prolonged drainage of a suppurative focus; (5) loss of body fluid, as in severe burns or diarrhea; (6) diminished absorptive area of the intestinal tract because of operative procedures (short-circuiting or resection).

Since the description of regional ileitis by Crohn, Ginzburg, and Oppenheimer,² there have been many discussions of the complications^{3, 4} of this disease entity. These are usually considered to be abscess formation, internal fistulas, external abdominal or perianal fistulas,⁵ and intestinal obstruction. Nutritional disturbances so extensive as to be a direct factor in the ultimate outcome have not been reported, and even lesser degrees of deficiency in nutritive elements are only occasionally mentioned in passing.⁶ The entire disease entity, its pathologic basis and clinical manifestations, should lead one to expect changes of this type, and they probably do occur much oftener than they have been reported. The severe diarrhea, which is the most common symptom, the extensive involvement of the absorptive area of the small intestines, the dietary restrictions upon which these patients are often placed, and the aversion to food which occasionally

is encountered lay the ground work for extensive changes in the body nutrition. Although the case herein reported is more extensive than any I have encountered in the literature, many cases are known where-in extensive involvement of the ileum and some involvement of the jejunum is present,^{7, 8} usually, however, with so-called free "skip" areas between.

The following case report is believed to be of interest for two reasons: (1) because of the extremely extensive involvement of small intestines; and (2) for the nutritional changes, manifested in marked depletion of the plasma protein content and avitaminosis. The case report follows:

CASE REPORT

D. A. (Hospital No. 69829), a white male, aged 22 years, was first seen by me on Jan. 18, 1938. At this time he complained of intermittent attacks of cramplike epigastric and periumbilical pain of two years' duration, severe diarrhea, fever, and loss of weight. Although there were periods of remission early in the course, the symptoms at the time of the first examination had been continuous over a period of several months. There were fifteen to twenty loose, watery stools daily. His appetite was poor and weight loss was marked. Previously he had received various medications and had been placed on bland diets with no improvement. His family history and past history were irrelevant. Physical examination at this time revealed a very poorly nourished male. The lungs and heart were normal. The abdomen was slightly distended and there was marked tenderness in both lower quadrants. There were no palpable masses and no edema was present at this time. A gastrointestinal x-ray series was taken and evidence of an extensive regional enteritis was found (Figs. 1 and 2). Operation was advised, an ileo-transverse colostomy with exclusion being contemplated.

The patient was not seen again until April 7, 1938. He had been operated upon at another hospital where a jejunotransverse colostomy without exclusion had been done. The high anastomosis had been necessary because of the extreme involvement of the entire ileum and terminal jejunum. At the time of this second examination, the malnutrition was much more marked; ankle and scrotal edema, ascites, and hydrothorax were present. Diarrhea was more severe and food intolerance more evident. The patient complained of severe abdominal cramps and dull pains in the bones and joints. Gastrointestinal x-ray studies showed a functioning jejunocolostomy with very rapid emptying time. On April 9, 1938, the patient was admitted to the Hospital for Joint Diseases. On admission the hemoglobin was 13 gm.; the red blood count was 5,120,000 per cu. mm.; the white blood count was 3,900 per cu. mm.; and the urine was normal. On April 13, 1938, the total serum proteins were 3.1 gm. per 100 c.c., the albumin fraction being 1.1 gm. and the globulin 2 gm. The albumin-globulin ratio was 0.55. The blood chemistry otherwise was normal. Immediate therapeutic measures, consisting of blood transfusion, high protein diet, vitamins, and parenteral liver, were instituted. At this time it became apparent that unless loss of nutritive elements as a result of the diarrhea could be stopped, the patient would succumb to the progressive malnutrition. It was realized that an extremely small amount of normal bowel remained, but it was felt that the hypermotility and resultant diarrhea were diminishing the effectiveness of the small remaining area of absorptive surface. The hypermotility was thought to be caused by the irritating action of the diseased bowel which was not excluded from the gastrointestinal continuity.

Operation* therefore was performed on April 14, 1938, a division of the bowel below the jejunocolostomy being performed with closure of both ends. The entire ileum, except for a few areas of apparently normal bowel, was involved in an extensive inflammatory process. The segments were thickened, boggy, and indurated, and the mesentery was also boggy and indurated. There were approximately 6 feet of normal bowel above the previously formed anastomosis. A small



Fig. 1.—Gastrointestinal x-ray with barium meal, one-hour plate. The involvement of the upper jejunum is noted showing the typical "string" sign.

piece of tissue was taken from the bowel wall. The pathologic report follows: The serosa is distinctly thickened, mainly due to edema, and is infiltrated by a number of lymphocytes and a few polymorphonuclears. There are a few scattered lymphocytes in the muscularis and submucosa; the latter is also somewhat edematous. No mucosa is present.

*The amount of small intestine that can be sacrificed is extremely large and cases have been reported in which over 18 feet of small intestine have been removed. Moynihan collected 54 cases of resections of more than 192 cm. and Watson collected 73 cases of resections of over 200 cm. of small bowel. Brenner resected 18 feet of small bowel, leaving 3 feet 5 inches and the patient survived two and one-half years. Jerrauld reported the resection of 19 feet of small bowel, leaving only 10 feet. Doerriller reported the successful resection of 18 feet 8 inches of bowel, leaving only 32 cm. of bowel below the duodenojejunal junction.^{2, 10}

The immediate postoperative reaction was good. There was a very slight febrile reaction which soon subsided. The frequency of the bowel movements diminished and never exceeded five per day in the postoperative period. Therapy continued with further transfusions, high protein diet, vitamins, etc. On April 16, the second postoperative day, the total serum proteins were 3.3 gm. per 100 c.c., with albumin 1.3 gm. and the globulin 2 gm. The albumin-globulin ratio was 0.65. This showed a slight improvement over the preoperative status. On April 22, 1938, the total

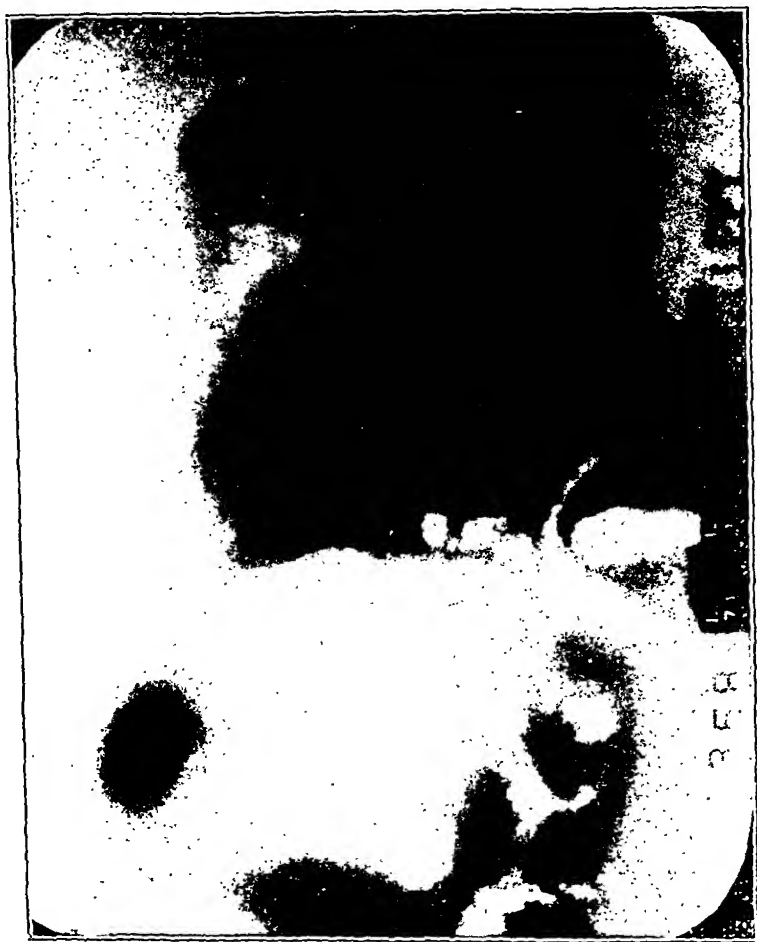


Fig. 2.—Two-hour plate. Dilatation of several lower intestinal loops is noted.

serum proteins had risen to 3.7 gm. per 100 c.c., with albumin 1.6 gm. and globulin 2.1 gm.; the albumin-globulin ratio was 0.67. On April 24, 1938, on the tenth postoperative day, complete dehiscence of the abdominal incision was noted. The wound edges were clean and free of infection, but were edematous, pale, glistening, and anemic. A secondary suture was performed, but wound healing failed to occur and when the patient died on May 2, 1938, there was still no evidence of healing. In spite of the slight improvement in the serum protein values, the edema and the ascites increased, the hemoglobin decreased from 14 gm. on April 15 to 9.4 gm. on May 2 and the patient became weaker and finally succumbed on May

2, 1938. At no time was there any evidence of peritonitis, and death was ascribed to malnutrition. No autopsy was permitted.

COMMENT

Depletion of the plasma proteins is one of the most important nutritional changes in surgical practice. This is usually manifested, when a critical level has been reached, by nutritional edema which may be so extensive as to cause ascites and hydrothorax, as in the case described above. The relationship between the serum proteins and nutritional edema has been stressed by many writers since Starling¹¹ in 1895 first postulated the existence of an equilibrium between the capillary blood pressure which tends to force fluids into the tissues and the colloid osmotic pressure which tends to draw fluids from the tissue spaces into the blood stream. Alterations in this equilibrium have been noted in cholera, dysentery, malnutrition, and nephrosis and have been produced experimentally by causing a hypoproteinemia in a variety of ways.¹²⁻¹⁴ These observations have confirmed the importance of the serum proteins as a controlling factor in the causation of nutritional edema.

The critical level of the serum proteins for the production of edema has been variously estimated and most observers conclude that edema invariably will occur when the serum proteins fall below 5 gm. per 100 c.c. Moore and van Slyke¹⁵ state that edema will occur at levels for the serum proteins below 5.5 ± 0.3 gm. per 100 c.c., when the plasma albumin values are below 2.5 gm. per 100 c.c. Jones and Eaton¹⁶ noted an average of 5.2 gm. per 100 c.c. at the time of the development of edema in their cases. Weech and Ling¹⁷ state that the critical level is about 5 gm. per 100 c.c. The albumin-globulin ratio, while frequently reversed, is not an important consideration in this type of edema, as, for example, it is in nephrosis. The globulin values are exceedingly variable and may be either increased, normal, or decreased, but decreased values only exist in the presence of a decrease in the albumin fraction and have no effect on the production of edema.

The albumin fraction of the serum proteins is the determining factor in the development of nutritional edema and is usually below 2.5 gm. per 100 c.c. in these cases. Weech and Ling¹⁷ state that in their cases, mostly patients with malnutrition or dysentery, they have never observed edema if the serum albumin was over 2.9 gm. per 100 c.c. and have never noticed the absence of edema when the serum albumin was less than 2.5 gm. per 100 c.c.

The clinical manifestations of hypoproteinemia are varied and may have an important and serious influence on the ultimate prognosis. Inasmuch as the edema which develops may involve the parenchymatous organs and the walls of the gastrointestinal tract, serious postopera-

tive complications may occur. Serious and occasionally fatal pulmonary edema¹⁶ often may be the first warning of an alteration in the body protein content. Intestinal obstruction as a postoperative complication, particularly after procedures involving the formation of a new stoma in the gastrointestinal tract, has been shown by Meecray and his co-workers¹⁸ to be due very frequently to the lowered serum proteins which cause edema and closure of the newly formed stoma. Others have corroborated this finding. In addition, the effect of hypoproteinemia on wound healing is of great significance.

As noted in the case reported above, no evidence of healing of the abdominal incision was noted during the entire postoperative course, in spite of the fact that no semblance of infection was present. The wound edges were pale, glistening, and edematous, and, although secondary suture of the wound was performed, no acceleration of the healing process took place. This condition has been previously observed both clinically and experimentally. Whipple and Elliott¹⁹ state that lowered serum proteins are a factor in retarding wound healing and Clark²⁰ and Harvey and Howes²¹ have noted that a high protein diet increased the rapidity of wound healing and eliminated the quiescent phase. Thompson, Ravdin, and Frank²² have shown that, in dogs with artificially induced hypoproteinemia, 72 per cent of the animals showed either disruption or delayed healing of abdominal incisions. The wounds in their experimental animals were pale, glistening, and edematous and showed little bleeding, a finding very similar to the one noted above. Microscopically, there was intercellular edema and greatly decreased fibroblast formation. Also, Thompson¹⁴ and his co-workers have shown that, if the concentration of the blood proteins in these dogs can be restored to normal and maintained there by the use of lyophilized plasma, wound healing will occur.

The importance of the vitamin balance in surgical states has been stressed recently. Although no specific laboratory tests were performed to determine the vitamin content, it seems apparent that this patient was suffering from at least an early form of scurvy. Lund²³ has observed a large incidence of lowered vitamin C levels in a series of varied types of surgical cases. Others have made this observation in cases of peptic ulcer, ulcerative colitis, and allied conditions. Vorhaus²⁴ has pointed out that there is greatly diminished absorption of vitamins in cases exhibiting alterations in the mucosa of the gastrointestinal tract or where diarrhea is marked, both factors being present in regional enteritis. Although the dangers inherent in this state are well-recognized, the importance of vitamin C in wound healing is just being appreciated. Wolbach and Howe²⁵ noted that wounds in animals with scurvy will not heal well; Vorhaus pointed out that collagen formation is markedly retarded in vitamin C deficiency states; and Lannan and Ingalls²⁶ have shown the relationship between ascorbic

acid and collagen formation and the inability of tissues deficient in vitamin C to produce intercellular substances necessary for fibroblastic repair. The last authors have produced asymptomatic scurvy in guinea pigs and have noted that healing was delayed and the wounds were of poor tensile strength.

It is apparent from the foregoing observations that the concept of the problem of wound healing must be broadened to include the factors of adequate vitamin balance and serum protein levels. Both clinical and experimental observations have shown these factors to be important, and, while the many other factors influencing wound healing should not be overlooked, it is probable that in the seriously ill surgical patient wound healing will be accelerated if replacement of vitamins and proteins is accomplished. It is well known that certain types of patients, e.g., carcinoma cases, will exhibit poor healing of their operative incisions. It may be possible that depletion of serum proteins and deficient vitamin balance are the causative factors in these cases.

This presentation illustrates the fact that nutritional disturbances of various types can and do occur in regional enteritis. As stated above, the severe diarrhea, the decrease in the effective absorptive surface of the small bowel, and the deficient diet upon which most of these patients subsist should lead the clinician to expect a deficiency in the nutritional state. This deficiency may be very severe and may be the lethal factor, or it may, as is most common, be very mild and not become obvious until an operative procedure has aggravated the pre-existing borderline state. In many cases edema may not be evident because of marked dehydration and will appear when the water balance is restored to normal. In other cases the excessive administration of saline solution in the postoperative state when oral feeding is contraindicated will be the causative factor in producing edema in patients with only mild hypoproteinemia. The effect of salt deprivation on patients with nephritic edema is well known.¹⁵ Weech and Ling¹⁷ have shown that the edema due to nutritional factors is similarly influenced by sodium chloride. Conversely, it has been shown by many observers that excessive salt intake in a seriously ill patient, when the kidney function is doubtlessly somewhat lowered, will cause edema,^{27, 28} and this is more certain if the serum proteins are depleted. The rational administration of salt to surgical cases by the method described by Bartlett, Bingham, and Pedersen²⁹ to make up the salt deficit and then the replacement of lost body fluids volume by volume with Ringer's solution or similar preparations is suggested. In this way adequate salt will be supplied and the harmful effect of the edema-producing potentialities of this essential substance will not be exhibited.

TREATMENT

Replacement of proteins in cases of hypoproteinemia in which the critical level has been reached is of the utmost importance. The frequent use of transfusions of whole blood or plasma is essential. High protein diets are of great benefit when feasible and where intestinal absorption is unimpaired. Milk, eggs, and gelatin are usually well tolerated and are a good source of proteins. The use of prepared or lyophilized plasma and synthetic amino acid²⁹ preparations is in the experimental stage, but may prove of great value. Digitalis, diuretics, and other cardiorenal stimulants are of no value in combating nutritional edema. In addition, vitamins are essential and should be administered in adequate doses, consideration being accorded to the possibility that there may be lack of absorption and utilization. The schedule of vitamin administration advocated by Vorhaus²⁴ for surgical cases seems adequate.

SUMMARY AND CONCLUSIONS

1. A case of extensive regional enteritis involving all but six feet of small intestine and exhibiting marked nutritional disturbances is presented.

2. Nutritional disturbances should be anticipated in this disease entity because of the nature of the pathologic changes which occur and the symptomatology.

3. Hypoproteinemia and avitaminosis are among the most important nutritional changes encountered in surgical cases.

4. The effect of these two states on postoperative complications and particularly on wound healing is briefly discussed.

5. Treatment consists of administration of protein by mouth and by transfusions of whole blood or plasma and an adequate schedule of vitamin administration, either orally or parenterally.

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NECROTIZING ARTERITIS (PERIARTERITIS NODOSA)

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IN 1852 Rokitsansky¹ noted certain nodules upon the coronary and mesenteric arteries of a man who had died suddenly with abdominal symptoms. Many years later a microscopic examination of these preserved tissues was said to show "periarteritis nodosa." Kussmaul and Maier² in 1866 first accurately described a definite inflammatory disease of the medium and small arteries and called the condition "periarteritis nodosa." Since their description, well over two hundred cases have been reported.

Necrotizing arteritis has been suggested as a more apt term than periarteritis nodosa for this condition. All the coats of the affected arteries are involved in the inflammatory necrotizing process and the nodules are not always found. The prominence of these nodes in the original conception of the disease no doubt justified the terminology, but today the very name of nodosa unfortunately may lead to lack of recognition of the condition, both before and after death. While preferable, necrotizing arteritis may still not be sufficiently distinctive to become the ideal name. Its most constant feature is the degeneration and hyalinization of the media of the small arterial blood vessels. It is not a common clinical or pathologic entity, but our present knowledge suggests that many times it has been mistaken clinically for various diseases of the kidney, heart, and abdomen, and at autopsy hemorrhages, infarctions, thromboses, and aneurysms have been discovered without a full appreciation of their significance as a part of the picture of periarteritis nodosa.

The condition seems more common in middle adult life, although case reports record 3 months and 78 years as the two extremes in age. The total number of cases reported is still too small to formulate definite conclusions, but thus far over two-thirds of the cases have been in the male sex. A survey of the literature and reports of cases emphasize the lack of uniformity of much of the statistical data about this disease.

Many theories as to etiology have been expressed but none universally accepted. Early attempts to show a relationship to syphilis have been unsuccessful. It is usually thought to have a background of infection. Its connection with streptococcic and mixed infections has been studied, and especially its relationship to rheumatic fever. Some investigators (Cohen, Kline, and Young³) think it due to "a manifestation of clinical allergy of severe degree."

The process begins as a necrosis of the media of the smaller arteries and arterioles. From the media the inflammation extends outward to

the adventitia and a periarteritis develops. It extends inward at the same time to the intima where necrosis may lead to thrombosis. Endothelial or subintimal proliferation causes a narrowing or occlusion of the vessel lumen. The part supplied by the vessel will become ischemic, and infective and nutritional disturbances are probable. All parts of the vessel wall show a marked leucocytic infiltration and beginning granulation tissue formation. With the damage of the arterial wall and the continued arterial pressure, the wall may give way in certain areas with the formation of false aneurysms, followed by rupture and hemorrhage. This constitutes the acute stage of the disease. It may become subacute and chronic, with the gradual replacement of the acute inflammatory elements by connective tissue, at first poorly organized, but in the end stage a fair type of scar tissue. Some canalization of the thrombi may occur and if not too badly damaged by the primary necrotizing process, there may be some return of the vessel function. The disease at times may be limited to small sections of the vessel with adjacent areas uninvolved. The veins and large elastic arteries do not show degeneration. The so-called nodules found at autopsy are formed by the multiple thrombosed aneurysms springing from small-sized vessels.

Arteries of all parts of the body may be affected. The renal, coronary, mesenteric, hepatic, and peripheral vessels, including those supplying peripheral nerves, are commonly involved. The arteries of one organ only or a part of one organ may be degenerated, or multiple organs and tissues may show the characteristic lesions.

The diversity of distribution in the pathologic picture suggests the multiplicity of forms that are encountered in the clinical course of the disease. Because of this complexity, classification of the disease into clinical types is difficult. The two aspects to be considered are the basic local degenerative changes produced in the small arteries of certain tissues or organs and the effect produced on those tissues or organs by the serious interference with blood supply.

Kernohan and Woltman,⁴ in reporting five cases, emphasized the nerve lesions produced and considered that "these are solely the result of inadequate blood supply." In common with other writers they have observed periarteritis nodosa at different stages of evolution, even in the same case. This probably explains the exacerbations and remissions which occur in this disease.

Distinctive symptoms will depend upon the organ most involved and the degree of that involvement. The renal, cardiac, peripheral nerve, or gastrointestinal symptoms may be the most pronounced. There is likely to be loss of weight and strength. Anemia and pallor may be marked. There is usually a low grade fever, and a syndrome suggestive of subacute sepsis may be present. Besides the inconstant nodes, there

may be various skin eruptions and purpura is common. Tachycardia is noted in some cases and hypertension in many. Symptoms referable to the kidneys are the most constant of all. Albuminuria is usually present.

The frequent involvement of the end arteries in the gastric, mesenteric, and hepatic circulations accounts for the nausea and vomiting, anorexia, cramplike abdominal pain, constipation, diarrhea and occasional hemorrhages. The symptoms may suggest an acute surgical abdomen and in certain cases, as of peritonitis from a ruptured viscus, one actually may exist. Multiple infarcts in the liver are found and liver and spleen are frequently enlarged. The white blood count may be normal, but it is usually increased and in 10 per cent of cases there is an eosinophilia. The negative blood culture may be of some significance.

In a high percentage of cases there is extensive involvement of the peripheral nerves of both the upper and lower extremities with pain, tenderness, anesthesia, paralysis, and nutritional disturbances. Special sense organs may be, but are less frequently, affected.

There is no dependable pattern for the clinical course in any case. The unexplained fever, the loss of weight and strength, the polyneuritis and polymyositis, the skin manifestations may lead to the correct diagnosis.

The difficulties of correct clinical diagnosis are shown by the many disease conditions to be differentiated from it. Miliary tuberculosis, typhoid, rheumatism, septicemia, hemorrhagic nephritis, cardiac insufficiency, trichinosis, dysentery, polyneuritis, hemiplegia, and several others have been clinical diagnoses made when autopsy or biopsy showed necrotizing arteritis. To this list the present case report adds carcinoma of the colon.

CASE REPORT

Mrs. W. K. first appeared at office for examination April 14, 1927. She was then 42 years of age, had been married twenty-one years, and was the mother of two children. She had been in a sanitarium six months previously for one month under treatment for severe daily headaches, nervousness, insomnia, and general weakness. All her teeth had been extracted a month before coming to office. She complained of severe headaches, vertigo, menorrhagia, and constipation. She had a systolic pressure of 192 and diastolic of 120. Her temperature was 99.5°. There was a trace of albumin in the urine. Her blood count showed 7,000 W.B.C. and 3,240,000 R.B.C., with a hemoglobin of 55 per cent. The Wassermann test was negative. Pelvic, as well as other general, examination was essentially negative. During the succeeding three months she appeared at the office four times and had an average of 1° of fever each time, except the last visit, when temperature was normal. Her systolic pressure dropped twenty points and other symptoms disappeared. No satisfactory explanation for the fever was found.

She next appeared at the office Jan. 11, 1932, four and one-half years later. Her complaints were very similar to those of her first appearance, as were also the findings. In addition, however, she now presented some very annoying skin eruptions, at first of an urticarial type and a month later, a purpura. She also

complained of pain and soreness in her right leg. The course was very like that of four years previously, with considerable improvement shown when last seen late in February, 1932.

Nothing more was heard from her until Jan. 28, 1935, approximately seven and one-half years after her first and three years after her second period of illness. She stated she had felt fairly well, except for headaches, until about Nov. 1, 1934. Most of the old symptoms gradually had recurred and recently there had developed considerable abdominal pain. This was of an aching rather than a cramping type and was definitely worse in the right lower quadrant. She had become markedly constipated and twice had noted what she thought to be blood in the stool. She had lost fifteen pounds in weight. Her systolic pressure was 215 and there was a good trace of albumin in the urine. There was some general abdominal tenderness, more marked on the right side, but no definite tumor mass was palpated. She consented to enter Mercy Hospital the following morning for proper examination. However, on her way home from the office, and within one block of her home, she had a sudden severe bowel hemorrhage. A large quantity of blood was lost and she was carried into her home in a condition of shock. Later the same evening she was transferred to the hospital.

During the following seventy-two hours, efforts to arrest the bowel hemorrhage, with the hope of more complete examination and treatment, were unsuccessful. On Jan. 29, the R.B.C. was 3,500,000; the hemoglobin, 60 per cent; and the W.B.C., 12,600 with 82 per cent polymorphonuclears, 15 per cent lymphocytes, 3 per cent monocytes, and no eosinophiles. Her blood pressure was 125/90.

On the third evening there was again a copious bowel hemorrhage and immediate intervention was decided upon as the only hope of relief. At this time a mass was plainly evident in the right lower quadrant. Under ethylene anesthesia, incision was made over the mass. This was found to be an irregular indurated obstructing tumor involving the cecum. The cecum with appendix and the adjacent ileum and ascending colon were mobilized sufficiently and delivered outside the abdominal wall by exteriorization procedure. This mass was removed by cauterization the following day. She seemed to rally under usual measures with blood transfusion, etc., but there was a complete suppression of urine following operation and she died with symptoms of uremia thirty-four hours later. Unfortunately no consent for autopsy could be secured.

The pathologist's (Dr. E. L. Benjamin) report on the specimen submitted was as follows: "The specimen received consists of the cecum, vermiform appendix, and the distal 6 cm. of the ileum. The large bowel measures 16 cm. The ileocecal valve is normal and admits the index finger with ease. The mucosa is smooth and gray-pink, except for a 4 by 5 mm. outpouching of the mucosa located 1 cm. distal to the valve. This contains blood. There are two other areas located in the mucosa of the cecum near the above-described lesion which are about 1 cm. in diameter and are a dull, pale gray and slightly depressed. The mesentery is firm to friable, heavily infiltrated, and red-brown to gray-red. The microscopic picture resembles a necrotizing arteritis with secondary thrombosis (Mikulicz procedure) of the secondary loops of the cecal branch of the terminal ileocolic artery with resultant coagulation necrosis and hemorrhagic extravasation. A certain period of time has elapsed between the onset of the pathologic process and the removal of the specimen. The evidence for this statement is revealed in the abundant secondary infiltration of the mesentery and the wall of the bowel by areas of degeneration of the mucosa of the cecum and beginning ulceration. The type cells consist of polyblasts, lymphoid cells, polymorphonuclear leucocytes, and macrophages containing hemosiderin, cellular debris, and fat globules. The muscle wall has been rent asunder by the marked extravasation, edema, and fibrin deposits. Fibrinoid necrosis is present along the peritoneal surface of the mesentery

and in the mucosal areas of degeneration. In some areas young granulation tissue is forming as seen by the angioblastic and fibroblastic proliferation and the tissue cell infiltration. The massive hemorrhage in all probability issued from a disruption of the vessels and mucosa in the area described above. The vermiform appendix is filled with blood, but it is otherwise normal. Diagnosis: Necrotizing arteritis with thrombosis, necrosis of the wall of the bowel and hemorrhage."

COMMENT

While the massive hemorrhage did not entirely fit into the picture, the clinical course in the last illness was more than suggestive of a carcinoma of the cecum. Speculation in this case is interesting. Were the attacks seven and three years before definite forerunners of the final one? We know the kidney is the organ most often involved in this disease and some kidney disturbance seems fairly probable from the first in this case as albumin was persistently found and complete anuria was the final cause of death.

Most of the reported cases of necrotizing arteritis have been discovered at autopsy. In most of them the clinical history has been brief. Remissions in the course of the disease may occur. It is possible many mild cases may exist and go on to spontaneous recovery without being recognized.

Theoretically any organ or tissue in the body may become involved in this pathologic process. The degree of necrosis, of degeneration, of thrombosis and infarction, of fibrous tissue replacement, and, in this case, of hemorrhage will determine the particular type of symptoms in the diseased organs or tissues. There is no specific pathognomonic symptom to suggest the actual diseased condition. With such a pathologic picture, the difficulties of an accurate diagnosis, except by biopsy or autopsy, are quite apparent. A hopeful sign is that, whereas all the earlier cases were first discovered post mortem, there are an increasing number being diagnosed ante mortem, either through a study of the clinical course or by biopsy. As we become more conscious of necrotizing arteritis, our percentage of correct diagnoses will improve. Is it too much to hope that with our greater knowledge some more satisfactory mode of treatment may be found?

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EDEMA AND CONGESTION OF THE LUNGS RESULTING FROM INTRACRANIAL HEMORRHAGE

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PATHOLOGISTS have observed at the autopsy table that in cases of intracranial hemorrhage there is often a marked pulmonary edema and congestion. Many theories have been advanced, but as yet there is no unanimity of opinion concerning the basic cause. The purpose of this study is to record the condition of the lungs in 686 cases in which death was due to intracranial hemorrhage.

HISTORICAL REVIEW

Hess¹ found pulmonary edema in cases of brain tumor, epilepsy with death during a convulsion, various diseases of the medulla, and diseases of the peripheral vagus. Of special interest is his observation that pulmonary edema results from injuries to the central nervous system. He reports that Montier in 1918 was the first to notice edema of the lungs after gunshot wounds of the head, the edema occurring within one hour after the accident, with a slow pulse and a rising blood pressure. Hess concluded that the cause of the edema of the lungs was related to both the vagus and the sympathetic innervation of the lung.

Brunn² produced edema of the lungs in dogs by section of the vagi followed by an intravenous injection of 1 per cent NaCl. He also noted that, if he ligatured the pedicles of the kidneys before cutting the vagi and giving intravenous NaCl, edema of the lungs did not develop.

Farber,³ working on rabbits and guinea pigs, reported results similar to those of Brunn. After bilateral cervical vagotomy, the lungs were found to be congested and edematous. With well-controlled experiments he demonstrated that neither laryngeal paralysis nor alterations in the heart were essential to the production of pulmonary edema, but that the loss of innervation of the lungs was the essential factor. Under direct observation he demonstrated that edema developed gradually and increased slowly in amount and that congestion preceded and accompanied the development of edema. He found further that there were in the rabbit lung strong parasympathetic vasoconstrictor fibers and weak sympathetic vasoconstrictor fibers. From this he concluded that "section of the cervical vagus nerves deprives the pulmonary vessels of a mechanism necessary in the adjustments of pulmonary vascular dynamics." He also concluded that "assuming some sympathetic vasocon-

strictor control is left intact—only a weak degree of tone can be present, and apparently in an amount insufficient to meet the demands of altered, or even normal pulmonary vascular dynamics.” From his conclusions on these animal experiments, Farber postulates that neuropathic pulmonary edema in man is perhaps caused by some disturbances, either peripheral or central, in the vasomotor control of the pulmonary vessels.

Benassi⁴ has reported some interesting and relevant observations. Working with dogs and rabbits, he increased intracranial pressure by injections after trephining and by draining blood from the carotid artery to the cranial cavity, in the latter case also performing a bilateral vagotomy. In both of these experiments the animals died with pulmonary edema and congestion. He cited a few clinical cases of death from pulmonary edema after cerebral traumatism, and he noted that there was less edema with an open fracture than with a closed fracture and the formation of a clot. From his experiments and clinical observations, Benassi concluded that in certain cerebral lesions the danger lies in the lungs and not in the brain, that pulmonary edema does not indicate merely trouble with the pulmonary circulation but trouble with the general circulation, and finally that pulmonary edema in his cases was due to a “hyperepinephrinism which entails a severe hypertension.” It would seem that this last conclusion regarding the “hyperepinephrinism” lacks sufficient experimental proof.

Much experimental work on pulmonary edema has been done by Moon and his associates, approaching the problem from the point of view of shock. In an early publication⁵ Moon concluded that an increased concentration of the blood is a constant feature of surgical or traumatic shock, the degree of concentration seeming to be in proportion to the degree of severity of the shock. He also concluded that the circulatory changes, e.g., congestion and edema of the lungs, are not characteristic of any particular type of shock, but are constantly the same in shock from any cause. Moon⁶ stated further that the shock syndrome, as produced in any manner, experimental or traumatic, is due to a “disparity between the volume of blood and the volume capacity of the vascular system.” He considers traumatic shock as sometimes due to absorption of substances which injure the capillary walls and thereby cause an escape of plasma into the tissue spaces with resulting hemoconcentration and circulatory failure “which are characteristic of shock.” In his experimental work Moon has found edema of the lungs more marked when shock develops gradually and death is not immediate; but when shock and death are rapid, congestion and capillary hemorrhages are more prominent than edema. He believes that many cases of pneumonia secondary to lesions of the central nervous system have their origin in this type of circulatory disturbance when neither death nor recovery occurs soon. Further work by Moon⁷⁻⁹ has substantiated his

conclusions as to hemoconcentration in shock and as to the role of shock in the production of pulmonary edema and congestion.

All of the work on shock done by Moon is condensed in his representation of the "vicious circle of shock,"^{10, 11} showing that injury to capillaries, capillary atony, hemoconcentration, and tissue anoxia are all inter-related in the production of edema and congestion and terminal pneumonia. Moon¹² considers congestion, stasis, and edema the essential pathologic pattern of shock and the initial factors in many cases of terminal pneumonia. It is of interest here to point out the work of Robertson¹³ who has found that in experimental lobar pneumonia the first stage is pulmonary edema.

There have been isolated accounts of pulmonary edema resulting from various therapeutic measures. Cooke¹⁴ reported a case of severe edema of the lungs in a young woman who died fifteen minutes after the injection of $\frac{1}{50}$ gr. of eserine. Nielsin and co-workers¹⁵ reported twenty-six cases of schizophrenia treated with insulin shock in which three developed serious but nonfatal pulmonary edema. Messinger¹⁶ reported peripheral vasomotor phenomena, e.g., flushing or pallor, with insulin shock treatment in schizophrenia.

At the present time it seems that shock, as described by Moon, would account for the pulmonary pathology seen in fatal cases of intracranial hemorrhage.

PERSONAL OBSERVATIONS

From the autopsy records of the Department of Pathology of the University of Minnesota, all the cases of traumatic and spontaneous intracranial hemorrhage during the years 1932 to 1937, inclusive, were selected for study. The following features of each case were recorded: sex, age, type of hemorrhage (spontaneous or traumatic), combined weight of the lungs, pathology of the lungs, and the time interval between the occurrence of the hemorrhage and death. As controls 200 cases were selected at random in which the lungs were normal and in which there was no intracranial lesion or heart disease. A total of 886 cases has been studied, which includes 226 cases of spontaneous hemorrhage, 460 cases of traumatic hemorrhage, and 200 control cases.

The sex distribution is shown in Table I. In the traumatic group there is a great preponderance of males, but both sexes are well represented in the other groups.

TABLE I
SEX DISTRIBUTION OF CASES OF HEMORRHAGE AND OF CONTROLS

	MALES	FEMALES	TOTAL
Spontaneous hemorrhage	143	83	226
Traumatic hemorrhage	396	64	460
Controls	85	115	200

In Table II it is shown that the distribution by age is essentially the same in all three groups. Therefore, any differences in the groups cannot be attributed to the influence of age.

TABLE II
AGE DISTRIBUTION OF CASES OF HEMORRHAGE AND OF CONTROLS

	TRAUMATIC HEMORRHAGE		SPONTANEOUS HEMORRHAGE		CONTROLS	
	NUMBER	%	NUMBER	%	NUMBER	%
10-20	23	5.0	3	1.3	6	3.0
20-30	63	13.7	12	5.2	22	11.0
30-40	74	16.1	20	8.9	28	14.0
40-50	84	18.3	45	19.9	40	20.0
50-60	84	18.3	53	23.0	37	18.5
60-70	78	16.9	46	20.4	34	17.0
70-80	43	9.4	37	16.4	27	13.5
80-90	11	2.4	8	3.5	6	3.0
90-100	0	0	2	0.8	0	0

The purpose of this study was to determine whether edema and congestion of the lungs are constantly associated with fatal intracranial hemorrhage and whether the pulmonary lesions found with spontaneous hemorrhage are different from those found with traumatic hemorrhage. The combined weights of the lungs in 460 cases of traumatic intracranial hemorrhage and in 226 cases of spontaneous intracranial hemorrhage are shown in Table III. It is seen that practically no differences

TABLE III
COMBINED WEIGHTS OF THE LUNGS IN ALL CASES OF INTRACRANIAL HEMORRHAGE AND IN CONTROL CASES

COMBINED WEIGHT OF THE LUNGS	TRAUMATIC		SPONTANEOUS		CONTROL	
	NUMBER	%	NUMBER	%	NUMBER	%
100-200	0	0	0	0	0	0
200-300	0	0	0	0	1	0.5
300-400	0	0	2	0.9	16	8.0
400-500	4	0.9	2	0.9	48	24.0
500-600	13	2.8	13	5.8	56	28.0
600-700	24	5.2	21	9.2	38	19.0
700-800	38	8.3	13	5.8	28	14.0
800-900	44	9.5	22	9.5	9	4.5
900-1,000	44	9.5	28	12.4	4	2.0
1,000-1,100	49	10.6	27	12.0	0	0
1,100-1,200	54	12.8	25	11.0	0	0
1,200-1,300	39	8.5	24	10.6	0	0
1,300-1,400	35	7.6	11	4.8	0	0
1,400-1,500	26	5.6	9	3.9		
1,500-1,600	28	6.1	9	3.9		
1,600-1,700	20	4.3	7	3.1		
1,700-1,800	14	3.1	9	3.9		
1,800-1,900	13	2.8	8	3.5		
1,900-2,000	3	0.7	3	1.3		
2,000-2,100	3	0.7	0	0		
2,100-2,200	2	0.4	2	0.9		
2,200-2,300	1	0.2	0	0		
2,300-2,400	0	0	0	0		
2,400-2,500	1	0.2	0	0		
	460	100.0	226	100.0	200	100.0

exist between these two groups. In this chart there are included the cases in which there was also a pneumonia, either macroscopic or microscopic. Of significance is a comparison between the weights of the lungs in the cases of hemorrhage and in the control cases. In the control cases only 2 per cent of the combined weights of the lungs exceeded 900 gm.; whereas, in the traumatic and spontaneous groups 73.3 per cent and 68.0 per cent, respectively, exceeded 900 gm. In the traumatic group 27.8 per cent of the cases with lungs weighing over 900 gm. showed pneumonia to some extent; whereas, the corresponding percentage in the spontaneous group was 32.3.

In Table IV the weights of the lungs are shown in all cases in which death occurred within twelve hours of the hemorrhage, those cases with pneumonia being excluded. It is to be noted that the traumatic and the spontaneous cases are distributed about equally in the various weight groups and that 64.9 per cent of the former and 74.6 per cent of the latter have lungs weighing over 900 gm., as compared with 2 per cent in the control group. In Table V the cases are shown in which death occurred within six hours of the hemorrhage. It is noted that in 64.2 per cent of the traumatic group and in 74.6 per cent of the spontaneous group the lungs weighed over 900 gm.

The question now arises as to how rapidly edema and congestion of the lungs develop. There were in the traumatic group 60 cases in which

TABLE IV

COMBINED WEIGHTS OF THE LUNGS IN CASES OF INTRACRANIAL HEMORRHAGE IN WHICH DEATH OCCURRED WITHIN TWELVE HOURS (CASES WITH PNEUMONIA ARE OMITTED)

COMBINED WEIGHT OF THE LUNGS	TRAUMATIC		SPONTANEOUS		CONTROL	
	NUMBER	%	NUMBER	%	NUMBER	%
100-200	0	0	0	0	0	0
200-300	0	0	0	0	1	0.5
300-400	0	0	0	0	16	8.0
400-500	3	1.4	1	1.5	48	24.0
500-600	10	4.6	4	5.9	56	28.0
600-700	18	8.2	3	4.5	38	19.0
700-800	20	9.1	3	4.5	28	14.0
800-900	26	11.9	6	8.9	9	4.5
900-1,000	25	11.4	9	13.4	4	2.0
1,000-1,100	28	12.8	9	13.4	0	0
1,100-1,200	24	10.9	5	7.5	0	0
1,200-1,300	14	6.9	6	8.9	0	0
1,300-1,400	18	8.2	7	10.5	0	0
1,400-1,500	11	5.0	3	4.5		
1,500-1,600	10	4.6	2	3.0		
1,600-1,700	7	3.2	3	4.5		
1,700-1,800	1	0.5	1	1.5		
1,800-1,900	2	0.9	1	1.5		
1,900-2,000	0	0	2	3.0		
2,000-2,100	2	0.9	0	0		
2,100-2,200	0	0	2	3.0		
2,200-2,300	0	0	0	0		
	219	100.0	67	100.0	200	100.0

TABLE V

COMBINED WEIGHTS OF THE LUNGS IN CASES OF INTRACRANIAL HEMORRHAGE IN WHICH DEATH OCCURRED WITHIN 6 HOURS (ALL CASES WITH PNEUMONIA EXCLUDED)

COMBINED WEIGHT OF THE LUNGS	TRAUMATIC		SPONTANEOUS		CONTROL	
	NUMBER	%	NUMBER	%	NUMBER	%
100-200	0	0	0	0	0	0
200-300	0	0	0	0	1	0.5
300-400	0	0	0	0	16	8.0
400-500	3	1.7	1	1.8	48	24.0
500-600	8	4.5	3	5.5	56	28.0
600-700	14	7.8	2	3.6	38	19.0
700-800	17	9.5	2	3.6	28	14.0
800-900	22	12.3	6	10.9	9	4.5
900-1,000	21	11.7	8	14.6	4	2.0
1,000-1,100	23	12.9	6	10.9	0	0
1,100-1,200	18	10.1	4	7.3	0	0
1,200-1,300	12	6.7	5	9.1	0	0
1,300-1,400	14	7.8	6	10.9	0	0
1,400-1,500	9	5.0	3	5.5		
1,500-1,600	6	3.4	2	3.6		
1,600-1,700	7	3.9	2	3.6		
1,700-1,800	1	0.6	1	1.8		
1,800-1,900	2	1.1	1	1.8		
1,900-2,000	0	0	2	3.6		
2,000-2,100	2	1.1	0	0		
2,100-2,200	0	0	1	1.8		
2,200-2,300	0	0	0	0		
	179	100.0	55	100.0	200	100.0

death occurred within one hour after the injury. Of these cases (Table VI) 56.7 per cent showed lungs weighing over 900 gm. The number of spontaneous cases with a time interval of one hour or less is too small for comparison. It appears that edema and congestion of the lungs in cases of traumatic intracranial hemorrhage develop within one hour to a point which is later exceeded but little, unless pneumonia supervenes.

There were 13 cases of spontaneous hemorrhage in which death occurred in one hour or less. The average combined weight of the lungs is 1,102.7 gm., with 9 cases out of the 13 showing a weight over 900 gm. One patient in this group lived only twenty-five minutes, but the combined weight of the lungs was 1,425 gm., due to a severe edema and congestion.

In the traumatic group there were 23 patients who lived one-half hour or less after the hemorrhage. In 17 of these cases the combined weight of the lungs was over 900 gm. One patient who lived only twenty-five minutes had lungs weighing 2,050 gm., due to severe edema and congestion. In 8 of 13 cases in which death occurred immediately the lungs weighed over 900 gm. It may be concluded that edema and congestion of the lungs develop in most cases of fatal intracranial hemorrhage within thirty minutes or one hour after the injury.

It appears probable from the foregoing observations that edema and congestion of the lungs are contributing causes of death in cases of intracranial hemorrhage.

TABLE VI

COMBINED WEIGHTS OF THE LUNGS IN CASES OF TRAUMATIC INTRACRANIAL HEMORRHAGE IN WHICH DEATH OCCURRED WITHIN 1 HOUR

COMBINED WEIGHT OF THE LUNGS	TRAUMATIC		CONTROL	
	NUMBER	%	NUMBER	%
100-200	0	0	0	0
200-300	0	0	1	0.5
300-400	0	0	16	8.0
400-500	1	1.7	48	24.0
500-600	4	6.7	56	28.0
600-700	4	6.7	38	19.0
700-800	6	10.0	28	14.0
800-900	11	18.3	9	4.5
900-1,000	5	8.3	4	2.0
1,000-1,100	9	15.0	0	0
1,100-1,200	6	10.0	0	0
1,200-1,300	4	6.7	0	0
1,300-1,400	3	5.0	0	0
1,400-1,500	3	5.0		
1,500-1,600	3	5.0		
1,600-1,700	0	0		
1,700-1,800	0	0		
1,800-1,900	0	0		
1,900-2,000	0	0		
2,000-2,100	1	1.7		
	60	100.0	200	100.0

CONCLUSIONS

1. The weights of the lungs in 686 cases of intracranial hemorrhage are recorded.

2. In about two-thirds of the cases the combined weight of the lungs is over 900 gm., while in a control group only 2 per cent show lungs of this size. The increased weight is due chiefly to edema and congestion, and partly to pneumonia.

3. There is no important difference in the lungs in the traumatic and the spontaneous groups.

4. Edema and congestion of the lungs develop to a severe degree almost immediately after an intracranial hemorrhage.

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PYONEPHROSIS IN CONGENITAL POLYCYSTIC KIDNEYS*

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POLYCYSTIC disease of the kidneys occurs with sufficient frequency to place it in the class of not uncommon diseases. Necropsy statistics support this view. Davis¹⁰ reports a collected series of 67 cases of polycystic renal disease in 23,900 necropsies; Oppenheimer,¹⁵ in two series, reports 27 cases in 8,060 necropsies; Braasch and Schacht,⁴ 9 cases in 9,171; Ward,²³ 40 cases in over 14,000; Spencer,²⁰ 7 cases in 1,600 necropsies. These reports show that polycystic kidneys occurred 150 times in 56,731 necropsies, or an incidence of 1:378. Stated more realistically, this disease occurs in a ratio of 1:3,500 in 220,000 hospital admissions and 1:3,253 in 680,000 admissions according to Oppenheimer and to Braasch and Schacht, respectively.

Braasch and Schacht,⁴ however, report a very high incidence of infection in these diseased kidneys; namely, 94 per cent in 193 cases; Oppenheimer¹⁵ in 60 cases finds "50 per cent of the cases showed some degree of mild infection as determined by the urinary findings while 32 per cent showed definite pus in the urine." In a clinical observation of 31 cases, 27 of which came to operation or autopsy, Cumming⁹ found pus and blood in the cysts of 19 (61 per cent). Davis states that in polycystic kidneys of adult life, especially after the age of 40 years, 80 per cent developed hemorrhage or infection or both. Many other reports of one or more cases are to be found with varying degrees of infection. The extent of the infection is usually reported on the basis of the microscopic examination of the urinary sediment. These findings are stated customarily in general and in indefinite terms; for example, occasional to many white blood cells; white blood cells in clumps or large quantities; much pus; variable number of pus cells; numerous pus cells; three-plus pus, etc. Such reports are meant to convey the degree of the existing urinary infection; they do not necessarily give the associated local pathologic extent of the infection. The degrees of infection in polycystic kidneys have been¹⁵ divided into three main types: "In one type there is found pyelitis, pyelonephritis, or infected hydronephrosis. A second type is purulent infection localized to individual cysts. A third type is a diffuse infection of the residual parenchyma as well as the cysts with occasional complicating

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perforation and perinephric abscess." Unless this additional information is given, the incidence of infection in polycystic kidneys, severe and extensive enough to be termed pyonephrosis, is more difficult to determine.*

We wish to discuss in this report those individual cases of infection severe enough to include two or three of the above-mentioned arbitrary groups which, as a result, would bring up for consideration the question of surgical intervention. When the laboratory data and the clinical course of the patient strongly point to the existence of such extensive pathologic involvement, we then consider the case as one of pyonephrosis. Young²⁴ states that "when a distended kidney pelvis contains pus it is known as a pyonephrosis, but the term is not exact, since there is no definite point of distinction between it and a slightly infected hydronephrosis. The interior of the pyonephrotic sac is irregular in shape, owing to the distention of the various calyces to communicating abscess cavities, or even to communications with the perirenal tissues, so that its proper drainage through the ureter or through an incision is often impossible. Such cases lead often to intoxication or septicemia."

It is stated² that "suppuration is rare" in congenital polycystic kidneys and from the few case reports (Table I) found in the more or less recent literature one would be led to subscribe to this view. On the contrary, the reported very high incidence of infections in polycystic kidneys would lead one to believe that these kidneys are quite susceptible to infection and, as a result of such susceptibility, a state of pyonephrosis should be apt to develop more frequently than the reports indicate. It is because of this belief and because of the desire to re-emphasize the seriousness of infection in kidneys, already poor in function or inadequately able to take on this additional burden, that we wish to report three cases of pyonephrotic polycystic kidneys.

One of us (A. E. G.) has encountered and examined twenty-nine cases of polycystic degeneration of the kidneys. The disease was bilateral in all cases. This was proved by operation, necropsy, or unequivocal bilateral pyelographic findings. Three, or 12 per cent, of these had undergone pyonephrotic changes on one side and necessitated surgical intervention, and primary nephrectomy was done in each case. Relief of complaints and general improvement were obtained in all three cases.

CASE 1.—N.R., male, barber, first seen in the out-patient department of Sinai Hospital, March 20, 1925, when he was 34 years old. He was complaining of pain in lower back of about nine months' duration. No urinary symptoms except an occasional voiding one time at night. Voided urine showed 4 to 5 white blood cells

*Since our paper was prepared, David M. Davis (*New England J. Med.*, June 9, 1938) expresses himself on the pathologic inexactness of the term pyonephrosis as now commonly used.

TABLE I
PYONEPHROSIS IN POLYCYSTIC RENAL DISEASE

AUTHOR	YEAR	NO. OF CASES	DIAGNOSIS	TREATMENT	RESULT
Richet ¹⁷	1920	1	Calculus pyonephrosis with perinephritic abscess	Nephrectomy	Death in 2 wk.
Chevassu ¹⁸ *	1921	4	Suppuration	?	?
Carajannopoulos ¹⁶	1926	1	Pyonephrosis	Nephrectomy	Recovery
Andre and Francfort ¹	1929	1	Infected polycystic kidneys; calculus and perinephritic abscess	Expectant	Death
Michaniewski ¹		2	(a) Severe infection and stone in ureter; (b) suppuration probably of hematogenous origin	Operation	?
Case reports ¹⁵	1929	1	Pyonephrosis	Nephrectomy	Recovery
Veckel ²¹	1932	1	Pyonephrosis and perinephritic abscess	Nephrectomy	Death in 12 days
Walters and Priestly ²²	1932	1	Pyonephrosis with gangrene	Secondary nephrectomy	Recovery
Lynch and Thompson ¹³	1935	1	Pyonephrosis	Nephrectomy	Well after 5 yr.
Geisinger ¹¹	1935	1	Pyonephrosis	Nephrectomy (2 stages)	Recovery
Goldstein and Klotz	1938	3	Pyonephrosis	Nephrectomy 11/22/35 6/5/36	Lived 2½ yr. Living 3 yr. Living 2½ yr.

*Collected 88 cases from the literature.

¹Quoted by Andre and Francfort; Michaniewski performed nephrectomy in 32 cases.

and an occasional red blood cell to high-power field; slight trace of albumin. Total intravenous phthalein revealed 42 per cent in sixty-five minutes. Cystoscopy at this time revealed 8 to 10 white blood cells to high-power field from the left kidney; right kidney urine was negative. Pyelogram of left side was read by roentgenologist as normal pelvis and calyces. Intravenous phthalein appeared in four minutes from the left kidney and gave 7 per cent in one-half hour; 23 per cent was collected transvesically during the same time. He received repeated lavages of left kidney up to October, 1925. In September, 1926, his urine was reported clear. He did not return to clinic until July, 1928, when he complained of voiding bloody urine at intervals for the previous three years. Cystoscopy now revealed blood coming from the left ureter.



Fig. 1.—Case 1. Right pyeloureterogram taken in 1928; the left taken in 1925. These show typical bilateral pyelographic findings in polycystic kidneys. Here the right kidney pelvis appears more dilated, but this is a later picture than on the left. The left kidney was removed.

The patient was admitted to the Sinai Hospital Medical Service on Aug. 7, 1928, and complained of pain in right side. Three weeks before admission he had a painless hematuria. Eight days before admission he had severe cramps in epigastrium; these later localized under right costal margin; deep respiration was painful and this was still present. In last few days he had no nocturia and was voiding much less urine. He had been having frequent headaches with occasional dizziness and slightly impaired vision; frequent epistaxis in past eight months; occasional edema of extremities and eyelids; anorexia for past three weeks; no nausea or vomiting; chronically constipated. The family history was noncontributory. In his past history he had had typhoid fever and typhoid osteomyelitis of spine at age 27 years; pleurisy at 35 years of age; hemoptysis, eighteen years ago. Now stated he had nocturia two to three times for eighteen years. Was told by insurance company nine years ago that he had kidney trouble. Married eighteen years; three children living and well. Weight was 130 pounds in 1927; present, 160 pounds.

Examination on admission revealed the following; Temperature, 99.8°F.; blood pressure, 136/90; abdomen negative, neither kidney palpable; external genitals normal; prostate normal, Hgb., 90 per cent (S), R.B.C., 4 million; W.B.C., 10,800 with 73 per cent polymorphonuclears. Urine showed specific gravity of 1.005 to 1.010; albumin, three plus; sugar, negative; microscopic examination of centrifuged specimen showed many W.B.C. with clumps, R.B.C., and casts. Intravenous phthalein showed 10 per cent in first hour and 5 per cent in second hour. Blood Wassermann negative; blood urea, 92 mg. per cent.

Cystoscopy and retrograde pyelography of right side (Fig. 1) revealed some elongation of pelvis and calyces, dilatation and blunting of the calyceal ends, and

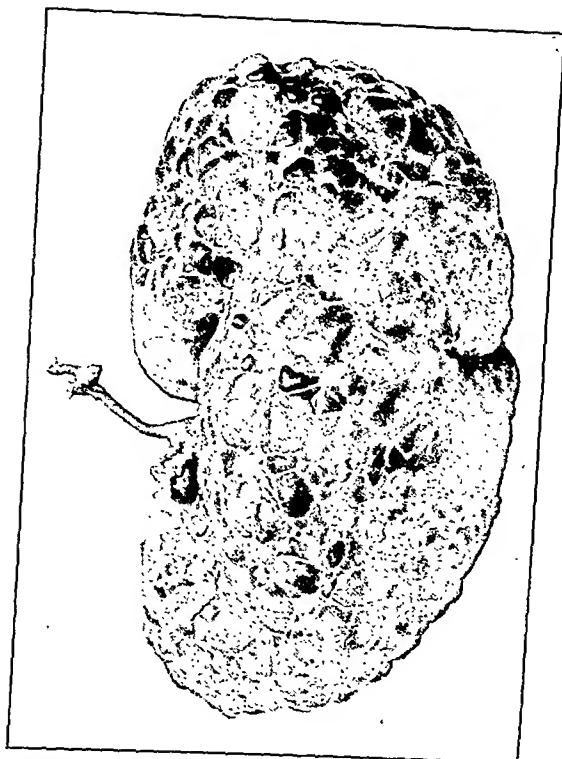


Fig. 2.—Case 1. Front view of the left kidney. This shows the multiple cysts of various sizes, typical of polycystic kidneys.



Fig. 3.—Case 1. Dissection of the left kidney again showing the multiple cysts. The elongation of the pelvis and calyces is not well brought out in the photograph.

a real right angulation of the ureteropelvic juncture. Both kidney shadows were enlarged. Re-examination of the left pyelogram taken in 1925 revealed findings very similar to the above except the right angulation then was not so marked. Diagnosis of bilateral polycystic kidneys with pyonephrosis on the left was made.

On Sept. 4, 1928, a left lumbar nephrectomy was performed under gas-ether anesthesia; convalescence was smooth.

Gross Pathology.—Specimen consists of a kidney measuring 20 by 11.5 by 9 cm. (Fig. 2). It is covered with numerous cysts on the anterior and posterior surfaces. Those on the posterior surface are more numerous and vary in size from 2 mm. to 2.7 mm. in diameter. On the anterior surface the cysts are more numerous at the lower and middle portions. The ureter measures 3 mm. in diameter. It appears to be normal. The pelvis is intrarenal. There seems to be a separate vein going to the superior pole. There is a separate group of vessels going to the lower and middle portions. On cross section (Fig. 3) there are numerous cysts present throughout the entire substance of the kidney, through both the cortical and medullary portions. Some of the cysts in the cortical and medullary portions are hemorrhagic and contain a hemorrhagic-like fluid. The pelvis is normal in size but shows some elongation, particularly at the middle and terminal portions; the calyces are markedly elongated. The walls of the pelvis are rather thick and show numerous areas of hemorrhagic infiltration. There is little or no renal parenchymatous tissue visible. The cysts appear to be separate and distinct and each is lined by a thin wall.

Microscopic Pathology.—Section 1, consists of a structure which is divided up into cysts. These are lined by an epithelium, cuboidal in shape, in single and multiple layers. The cysts vary in size. There are numerous small ones, and occasional remains of tubules lined by similar epithelium. Occasionally, there are casts present in these tubules. The cysts themselves contain material which resembles serum. Occasionally there is fresh and old hemorrhage and phagocytic cells containing blood pigment.

To prove definitely that the disease was bilateral in this case, the right kidney was explored Sept. 21, 1928, through a short lumbar incision. A typical polycystic kidney was found. Convalescence again was uneventful and patient was discharged Oct. 2, 1928. On Oct. 15, 1928, his phthalein was 15 per cent in seventy-five minutes; Nov. 14, 1928, it was 10 per cent in sixty-five minutes; Jan. 2, 1929, it was 9 per cent in sixty-five minutes. He was seen in the follow-up clinic Dec. 1, 1929, where it was reported that he had gained 12 pounds. He had nocturia one time, voided four to five times during the day. There were no other symptoms. Both wounds were well healed. He was seen once more and then failed to return. He died at home Feb. 11, 1931, after three days of complete anuria, almost two and one-half years after operation.

CASE 2.—A.E.U., single male, aged 24 years, was first seen Aug. 14, 1935. Complained of pain in right side and back. Family history was noncontributory. Past history revealed auto accident nineteen years ago; patient struck on right side with a baseball about seven years ago; tonsillectomy, 1932; grippe, 1934; frequent head colds which intensify symptoms of present illness; fractured right ankle one year ago.

Present Illness.—Six years ago had peculiar pain in right abdomen and back. Pain relieved by pressure and by lying down. Pain not sharp and at times radiated to root of penis. Certain foods brought on the discomfort as did frequent head colds. Appendicitis was considered but changed to kidney trouble. At that time he was cystoscoped about twenty-five times, with relief after each treatment. No treatment in past five years, during which time he had felt fairly well. At present he has an occasional annoying feeling on the right side. No urinary frequency. No nocturia, urgency, hesitancy, or hematuria; no stones passed; no nausea or vomiting. Present weight, 160 pounds; no recent loss.

Abdominal examination revealed the right kidney palpable, left kidney not palpable, and slight tenderness in right lower quadrant. External genitals were negative. Rectal examination revealed prostate of normal size and consistency. Voided urine cloudy; albumin, one plus; sugar, negative; 100 W.B.C., with clumps to high-power field in the centrifuged sediment. Methylene blue stain revealed no organisms. Blood pressure, 110/70.

Plain x-ray showed right kidney elongated, left normal. Cystoscopy revealed normal bladder findings except for some redness around right ureteral orifice. No. 6 catheter passed up each side without obstruction. Left kidney urine clear and negative for pus cells; right kidney urine slightly cloudy and showed many pus cells. Capacity right kidney pelvis was over 25 c.c. Right-sided ureteropyelogram showed pelvis markedly dilated and dilated and blunted calyces with little cortical tissue. Ureter was dilated in some places. (Fig. 4.) Intravenous phthalein two weeks later showed no dye from the right kidney and 20 per cent from the left kidney in twenty minutes. Operation was advised for the right-sided pyohydronephrosis.



Fig. 4.



Fig. 5.

Fig. 4.—Case 2. Retrograde pyelogram, showing dilatation of pelvis and calyces and reduced amount of cortical tissue. With pus coming from the right kidney, the diagnosis of pyonephrosis in an otherwise normal kidney was warranted. Note the absence of all pyelographic findings usually characteristic of polycystic kidneys.

Fig. 5.—Case 2. An enlarged left kidney and definite elongation of the calyces are to be noted here in a man only 24 years of age. The findings were considered sufficient to make the diagnosis of polycystic kidney on this side, since operation revealed a polycystic kidney on the right side; furthermore, three years postoperatively this right kidney was palpable and nodular.

On Nov. 22, 1935, under gas-oxygen anesthesia, a right nephrectomy was performed through a lumbar incision. In addition to being pyonephrotic, the kidney was polycystic. Convalescence was uneventful and patient was discharged from hospital on Dec. 9, 1935. In the hospital the specific gravity of urine ranged from 1.016 to 1.020; albumin, one plus. Postoperative urine showed 4 to 6 W.B.C. to high-power field and no R.B.C. or casts. Blood urea was 30 mg. per cent on admission and 33.5 mg. per cent on discharge. The highest was 49 mg. per cent on the first postoperative day.

Gross Pathology.—Specimen consists of a kidney measuring 12 by 6 by 4.5 cm. (Fig. 6). The kidney presents numerous large and small cysts, elevated and chocolate in color. The largest cyst is about the size of a walnut and the smallest is about the size of a pinhead. The cysts are on both surfaces. The pelvis is extrarenal and measures 7 cm. in diameter. The ureteropelvic juncture makes its exit in a normal fashion and is apparently in a higher position than usual because the pelvis below this juncture has a pouch-like shape. The pelvis contains purulent urine. On bisection there is a discharge of some purulent urine and also some clear and chocolate-colored fluid. The pelvis is considerably dilated and the calyces likewise. The mucous membrane of the pelvis is smooth for the most part. The entire cortex is replaced by large and small cysts which do not seem to communicate with the calyces. There is no evidence of any normal cortical tissue. There is no visible perirenal fat. On incision of the pelvis down to the point of the ureter, it is observed that there is no stricture present but just a narrowing of the ureter, which, when opened, measures 7 mm.

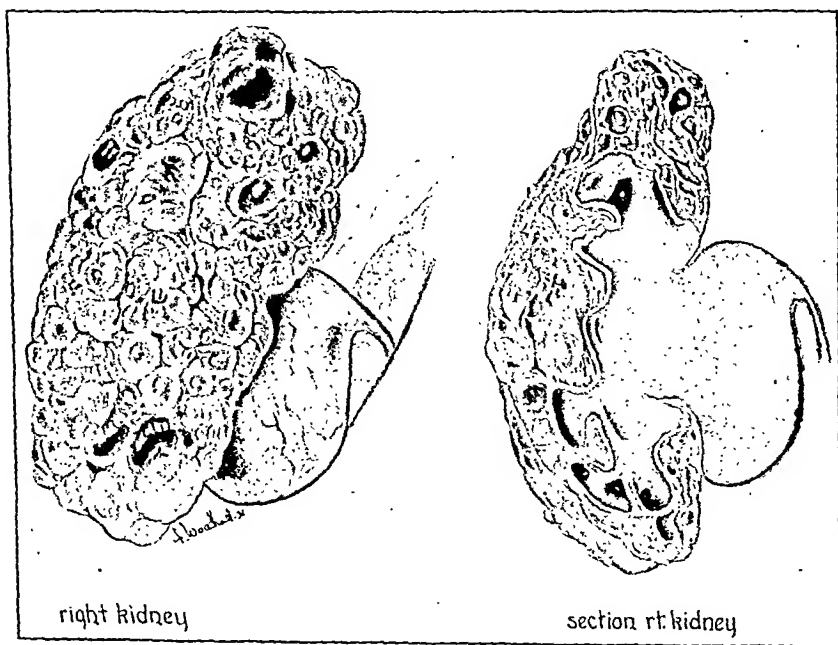


Fig. 6.—Case 2. Drawings of the right pyonephrotic polycystic kidney during and after its removal. Details are given in the pathologic report.

Microscopic Pathology.—Section 1 is that of kidney showing many tubules which contain polymorphonuclear exudation. The epithelium of the convoluted tubules shows almost complete destruction. There are several circumscribed areas of abscess formation in the interstitial tissue. There are numerous round cells throughout and a number of cystic areas containing mucoid material.

Section 2 from the pelvis of the kidney shows numerous round and spindle cell infiltrations throughout the muscular coat. The mucosa is absent. There is a small circumscribed abscess present in the muscularis.

On Jan. 8, 1936, pyelogram of left kidney with 25 c.c. of skiodan revealed very much elongation of pelvis and calyces with no dilatation of the ureter. Diagnosis of polycystic kidney was made (Fig. 5).

This patient was seen monthly during the first half of 1936 and he was in excellent health. Urine showed none to only occasional W.B.C. per high-power field. He was last seen January 5, 1939 and he was steadily at work. He now was at his best weight, 170 pounds. Urine was yellow, clear; acid reaction; specific gravity, 1.009; albumin, slightest possible trace, and microscopically negative for cellular elements. Intravenous phthalein showed 60 per cent in sixty-five minutes. The remaining kidney is palpable and nodular.

CASE 3.—E.Y., married male, aged 38 years, was admitted to Sinai Hospital May 20, 1936. Complained of swelling of ankles for three weeks and urinary frequency for eight days. Family history was noncontributory. In his past history he had typhoid fever at 11 years of age; nocturia once a night for many years; otherwise



Fig. 7.—Case 3. Bilateral elongation of pelvis and calyces, more marked on left. Bilateral right angulation of ureteropelvic junctures is faintly visible. Pus in left kidney.

it was noncontributory. Present illness began April 10, 1936, when he felt tired and weak while working and had anorexia. Two days later he left work and has not returned because of chills and pains and aches all over. Soon had pain in right lower back. Remained in bed for few days. On April 17, he developed a severe sore throat with fever and was isolated in another hospital for three days because of suspected diphtheria. About three weeks before admission, he noticed swelling of ankles and cloudy urine. For past eight days he has had urinary frequency, voiding at onset as often as twenty times during the day and four to five times at night. He has lost 30 pounds in weight in past month; average weight, 166 pounds. No hematuria, dysuria, or nausea or vomiting. Examination revealed a tall man, looking chronically ill and showing evidence of loss of weight. The right kidney was barely palpable; the left was nodular and extended down to the crest

of the ilium and almost over to the umbilicus and it was not tender. The external genitals and prostate were normal. Blood pressure, 110/70; blood urea, 48 mg. per cent; specific gravity of urine ranged from 1.001 to 1.013; albumin, two plus. Voided urine microscopically showed many pus cells with clumps, occasional red blood cells and cast and cocci on staining. Intravenous phthalein showed 10 per cent in the first hour and 20 per cent in the second hour. Cystoscopy May 29 revealed a normal vesical orifice and bladder. Urine from right kidney showed 1 to 2 W.B.C. per high-power field; urine from left kidney revealed large quantities of pus with clumps. Culture of urine from each kidney revealed *Staphylococcus albus*. Intravenous phthalein appeared from the right kidney in nine minutes and 10 per cent was collected from this side in fifteen minutes, but none appeared from the left during the same time. Retrograde pyelogram with 25 c.c. of skiodan on the right and 30 c.c. on the left revealed bilateral elongation of pelvis and calyces, some dilatation of pelves and calyces, and right angulation of ureters, more marked on the left (Fig. 7).



Fig. 8.—Case 3. Surface view of a typical polycystic kidney.

Temperature went up to 102°F. daily until May 26 when the highest was 100° up to time of operation.

On June 5, 1936, a left nephrectomy was done through a lumbar incision. The vena cava was torn and sutured. A small piece of adrenal was also accidentally removed.

For the first postoperative week the temperature ranged between 100 and 102° and then returned to normal and remained so. The highest postoperative urea was 83 mg. per cent.

Gross Pathology.—Specimen consists of a left kidney weighing 1,195 mg. and measuring 23 by 13 by 10 cm. (Fig. 8). It is irregular in outline. For the most

part, it is semisolid in consistency. Shining through the capsule are seen numerous cysts of various sizes, shapes, and colors. On bisection (Fig. 9) there is a discharge of thick, foul-smelling pus from the upper pole. This is observed to be coming from several cysts that do not seem to communicate with the pelvis or the calyces. Numerous cysts can be seen bulging in the pelvis and calyces but not directly communicating with them. For an area of 5 cm. in the lower pole of the kidney there is marked degeneration of the tissue which seems to have undergone infection and necrosis. The pelvis and calyces are both dilated and elongated.

Microscopic Pathology.—Section is that of kidney showing marked degenerative changes throughout. There is necrosis of the tubular portion of the kidney and replacement by leucocytic infiltration. There is modification of the glomeruli with atrophy of the tufts and bloody extravasation in them. There is marked dilatation of the tubules and their lumina contain casts of pus and epithelium. In the tubular portion there is marked edema and replacement of the necrotic tubules by polymorphonuclear and red blood cell exudation. Other sections showed a similar picture.



Fig. 9.—Case 3. The picture of the pelvis and calyces resembles that shown in the pyelogram. See pathologic report.

On discharge June 27, 1936, his voided urine was still full of pus. The blood pressure was 122/78; there was only slight ankle edema and he felt much stronger.

The patient was again seen on May 4, 1938. Has been working. He felt fine and looked fine. His weight was 160 pounds. He had no urinary frequency and only an occasional single voiding at night; no pain. The right kidney was now palpable at the umbilicus and small nodules could be felt. There was a herniation at the operative site. Blood pressure was 135/90. Voided urine: specific gravity,

1.016; albumin, very faint trace; microscopic examination of centrifuged specimen showed 50 to 100 W.B.C. to high-power field.

He was last seen Jan. 20, 1939, two and one-half years after operation, and was in good health except for "catching" frequent colds which lasted longer than usual. His weight was still 160 pounds and his blood pressure was now 144/90 mm. Abdominal examination revealed the right kidney easily palpable and nodular below the right costal margin; on deep inspiration it could be felt just below and lateral to the umbilicus. Voided urine was yellow, cloudy; specific gravity, 1.010; albumin, faint trace (an increase); microscopic examination of centrifuged sediment showed only 25 to 50 W.B.C. with small clumps per high-power field, rare R.B.C. and rare granular cast. Intravenous phthalein revealed 32 per cent in sixty-five minutes.

The symptoms, signs, and various diagnostic points are quite familiar to all, but a brief review is in order because of some of the important differential diagnostic points. In the history of these patients one is impressed with some few symptoms and signs that are of extreme importance. They are as follows:

A. History.—

1. *Pain*: This is described as a dull ache, discomfort, or pressure pain; at times it may have been sharp. This symptom alone will not aid in differentiating from renal tumor, passage, or presence of blood clots or calculus, etc.

2. *Symptoms of Renal Insufficiency*: Headaches, dizziness, digestive disturbances, edema, urinary frequency day and night, loss of weight, weakness, etc., will cause one to differentiate this disease from the different nephritides in young adults and chronic cardiovascular-renal disease in older individuals. Bilateral renal enlargement (manual or x-ray) strongly favors polycystic kidneys.

3. *Hematuria*: This is a very common symptom (frequently the first symptom) and in the presence of an enlarged nodular kidney should make one suspicious of this disease; if both kidneys are palpable and nodular then one should be more than suspicious. The presence of hematuria always calls for an explanation, even if repeated attempts and exhaustive studies are necessary.

4. *Pyuria*: The presence of a few pus cells coming from one or both kidneys is indicative of an infection but not of a true pyonephrotic condition, which is less common.

5. *Enlargement of Abdomen*: If it is at all noticed by the patient, it will be noticed as a rule on one side. Examination, however, will disclose this mass to be distinctly nodular but not especially tender unless extensive infection is present.

B. Laboratory.—

1. *Blood Pressure*: This may be either high, low, or normal. The higher pressures can be taken as an index of the seriousness of the renal involvement, but the normal pressures do not preclude this.

2. *Phthalein*: Depending upon the pathologic extent of the disease and the time of life at which it is first seen, the percentage of function will vary. A low phthalein is the usual finding but almost normal and even traces only may be found. The appearance time is delayed with more extensive renal damage.

3. *Blood Urea*: Like the other data, this may also be normal or elevated. When elevated, the urea level may reach the heights usually seen in other common forms of renal damage, such as the nephritides. In polycystic renal disease there is no correlation between the blood urea level and the percentage of phthalein excreted.

4. *Urinary Examination*: Characteristic is a consistently very low or moderately low specific gravity which, however, may be high. Albumin is most frequently present in traces. Microscopically, red blood cells and casts are frequently seen but by no means constantly. As already stated infection as evidenced by pus cells is a very frequent finding but as a rule not in large quantities.

5. *Pyelograms*: This, by far, gives the most conclusive information. Should there be suspicious findings on one side and should the other side show typical findings, the diagnosis is then certain. The typical findings in uncomplicated polycystic renal disease are normal sized or slightly dilated pelvis and calyces; right angulation at the ureteropelvic juncture with ureter pushed medially; elongation of the pelvis and calyces; flattening and broadening of terminal calyces; absence of clubbing of terminal calyces.

The more seriously affected side may show more marked dilatation of the pelvis and calyces and because of the presence of a large abscess may be mistaken for simple pyonephrosis. Should, however, bilateral pyelograms be taken, this differential point will be observed (Case 2). Similarly, neoplasms may confuse the pyelographic picture, but there is little chance of error with bilateral pictures if one bears in mind the rare occurrence of bilateral neoplasms. We do not hesitate then to make the diagnosis of uncomplicated polycystic renal disease when we find evidences of renal insufficiency; bilateral, irregular, renal masses; bilateral, typical, or almost typical pyelograms. The diagnosis of pyonephrotic polycystic kidneys will be discussed under the differential diagnosis.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

Because of practical diagnostic importance, it is well to remember that this disease is congenital, always is bilateral, and may manifest itself in infancy, at or soon after birth; these infants promptly die. Most commonly the condition is not manifested until adult life in the third, fourth, and fifth decades. Patients presenting themselves in these decades have been arranged¹⁶ in groups according to the mode

in which the disease makes itself apparent; i.e., in one, there appear sudden, acute, and severe signs of renal insufficiency with more or less prompt death; in another, most commonly recognized clinically, one finds signs of renal insufficiency in palpable, bilateral, nodular kidneys; in the third group, the cardinal signs of renal tumor are present; namely, pain, tumor, and hematuria.

The most common conditions which must be differentiated from polycystic kidneys are: (1) chronic nephritis, (2) bilateral renal neoplasms, and (3) unilateral or bilateral pyohydronephrosis.

We are particularly concerned in this paper with the last group and we shall confine our discussion to that group.

In the diagnosis and differential diagnosis of pyonephrotic polycystic kidneys one will necessarily first make a diagnosis of polycystic renal disease, depending upon history, low specific gravity of the urine, the decreased phenolsulphonphthalein, the increased blood urea, and finally the typical bilateral pyelograms as already described. These points, plus the presence of a pyuria from one or both kidneys, further distorting the pelvis or calyces, should make the diagnosis simple. One should become quite suspicious of pyonephrosis (infected hydronephrosis) without polycystic renal disease when in the pyelograms (retrograde) one finds: (a) an irregularity in the pelvis or in a calyx together with a dilatation of either or both of these areas; (b) an absence of an elongation of the pelvis and calyces; (c) an absence of the medial displacement of the ureter. Should these data, suggestive of pyonephrosis, be obtained on one side and data typical of uncomplicated polycystic kidney be found on the other side, then the diagnosis of polycystic renal disease must be made because this disease is always bilateral.

Confusion, however, is most apt to arise when the above-mentioned data suggestive of pyonephrosis are found in both kidneys. Here again the diagnosis of bilateral polycystic kidneys should be given first and foremost consideration because this disease is of much more frequent occurrence than is bilateral pyonephrosis in otherwise normal kidneys. When this perplexity arises, it should result from the interpretation of retrograde pyelograms only. Renal exploration may be necessary to prove conclusively this differential point.

Treatment.—It is commonly stated that the treatment of uncomplicated polycystic renal disease and those cases complicated by mild infection, bleeding, or pain as a rule must be conservative. This will be confined to repeated catheterizations, pelvic lavages, rest, and repeated blood transfusions. With this we agree. We feel that it is also conservative to establish our temporary nonurinary nephrocutaneous fistulous tract¹² in some cases where the complaints are essentially those due to pressure by the growth of the cysts. There is no such common ground when it comes to the surgical treatment of the severely infected and very poorly functioning polycystic kidney.

Meltzer¹⁴ in 1929 reported 111 cases of surgical polycystic kidneys collected from a questionnaire sent to members of the American Urological Association. Ten different procedures were done in these cases, ranging from exploration to nephrectomy, the latter being performed in 53 per cent of the cases. Lowsley and Beer in discussing this paper express the opinion that the less one does surgically to those patients, the better off they are. One report¹ in writing of infected polycystic kidneys states that there is no greater mortality if one does not operate and that nephrostomy in normal polycystic kidneys gives a 45 per cent mortality.

Many urologists^{3, 11, 15, 18, 19} consider surgical intervention necessary and even mandatory in some cases of severe infection and in cases of persistent, prolonged bleeding or anuria. We wish to subscribe to this view. Chevassu,⁷ in his collected series of 88 cases of suppuration, found that primary nephrectomy yielded only 16 recoveries in 25 cases and only 3 of these were still living four to ten years later. In cases of pyonephrosis it might be more conservative to do a nephrectomy early before the infection extends markedly beyond the confines of the kidney and before the patient's vitality is excessively lowered.

A few cases requiring more than one operation were encountered in this review. In the last analysis, each case of polycystic pyonephrosis must be carefully studied from all the data available and each will call for keen and mature surgical judgment. At best one cannot hope for too promising remote results. It is still true as Clairmont⁸ stated in 1925 that in cases of bilateral polycystic kidneys there are yet no dependable indications for nephrectomy or for conservative interventions, based on thorough functional tests.

SUMMARY AND CONCLUSION

A review of the recent literature on pyonephrosis in polycystic kidneys has been made. Fourteen cases with sufficient data to warrant such a diagnosis have been found; we add three of our own.

From this review and from our own experience, we are of the opinion that some cases of pyonephrosis in polycystic kidneys urgently demand surgical intervention and at times this must be a nephrectomy. We also feel that probably better immediate results would be obtained if nephrectomy were done earlier. Some of the poorer results might be due to delay. At best we can only hope to improve the immediate situation.

Each case must be carefully studied on its own merits. It then requires calm, keen, surgical judgment more urgently probably than any other renal disease requiring surgical intervention.

To be on common ground, there is need for uniform classification of the lesion commonly termed pyonephrosis.

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PATHOLOGIC CONSIDERATIONS OF SARCOMA OF THE MAMMARY GLAND*

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PERHAPS nowhere in the realm of surgery has the classification of disease entities or the pathologic nomenclature of diseases been more misleading and confusing than in the case of the mammary gland. It is true that since the turn of the century the increase in clinical and microscopic research has dispelled to some extent the almost Stygian darkness in which the pathologists of that era found themselves in regard to this subject. Carcinoma of the breast, with its varied pathologic picture, has been given an almost standard nomenclature. In contrast, sarcoma of the same organ enjoys almost as many classifications as there are authors to describe them, and the relation between pathologic type and clinical course is still somewhat obscure. A thorough review of most of these articles still leaves the reader in a quandary when an interpretation of a complex term that designates a specific type of mesodermal malignancy is involved. The lack of good criteria for diagnosis and the use of the term "sarcoma" as a catch-all for all tumors not distinctly epithelial in nature are two of the main reasons for this confusion. As usual, medical terminology has far from kept pace with medical progress, and contemporary pathologists and surgeons are still employing an archaic nomenclature.

Although a confusing terminology has been used, considerable interest in sarcoma of the breast has been made manifest. Among the earliest references to a mammary neoplasm, which probably was sarcomatous in nature, was that of Morgagni, who has given us, in his letters, an engagingly communicative description of this pathologic entity, which was present in the breast of a Paduan nun. During the nineteenth century, articles in which one or more cases were reported became increasingly frequent. The "ossific and cartilaginous tumor of the breast" described by Cooper has long been a favorite reference in articles concerning sarcoma.

The embryology of the structures that give origin to these tumors is of some interest. It will be recalled that the mammary gland is a result of

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the development of ectodermal and mesodermal elements. The beginnings of the breast are first seen at about the third month of intrauterine life when a number of ectodermal invaginations are found along the milk ridge. Ducts and acini are derived by a process of differentiation from the latter; whereas, the mesodermal contributions are the connective tissues, fat, smooth muscle, and blood and lymphatic vessels. The connective tissue of the breast is a derivative of the pectoral fascia and invests the entire gland, while the ramifications form the interlobar and interlobular investments. The suspensory ligaments are merely the points of attachment of this tissue to the skin. Smooth muscle, excluding that in the walls of the blood vessels, is present in only small amounts and is situated in the nipple and about the ducts and acini. In the latter a single layer of longitudinally arranged unstriated muscle lies between the basement membrane and the adjacent layer of connective tissue. External to the elastica, which surrounds the ducts, is a thicker layer of smooth muscle.

Various ideas have been propounded from time to time to account for the development of sarcomas from the tissues just described, but the underlying etiologic agent or agents are, as with other malignancies, still undetermined. As early as 1911, Coley cited a number of cases to prove his contention that trauma was the spark that kindled the flame of sarcoma. However, the facts that great numbers of breasts have suffered injury of some type and that sarcoma has not followed in sufficiently significant frequency tend to militate against a complete acceptance of this hypothesis. There is no doubt that heredity and the ovarian hormones play some role in the development of the malignant mesodermal deviations, but again the exact weight to be assigned to such factors is still an open question. Cohnheim's hypothesis offers a somewhat more rational explanation of the mixed teratoid malignancies. As far as the growth of the neoplasm is concerned, sufficient illustrative evidence has been published to show the baneful effect of pregnancy and lactation. It should again be emphasized that the arguments for or against the acceptance of any particular etiologic agent can be met in rebuttal by any number of valid objections and that the present state of our knowledge does not permit any one cause to be stated as the true one.

The statistical incidence of sarcoma of the breast has declined steadily since the earlier reports because of the sharpened acumen of the pathologist and a correlation of clinical and pathologic evidence. A study of the data in Tables I and II will demonstrate the decreased frequency of these malignant lesions. One of the reasons for the decrease is that cystosarcoma phylloides is no longer classified as sarcomatous.

The classification of the sarcomas of the breast is approached with some difficulty, for, as has been previously stated, confusion reigns supreme in this field. However, Gross, in 1887, offered a somewhat simple type of nomenclature which, although not entirely correct, would have

TABLE I

FREQUENCY OF SARCOMATOUS LESIONS REPORTED IN THE LITERATURE

AUTHORS	YEAR	TOTAL NEOPLASMS STUDIED	SARCOMAS	
			NUMBER	PER CENT
Schmidt	1889	150	7	4.7
Poulsen	1891	355	33	9.3
Williams	1892	2,422	95	3.9
Gebele	1901	359	34	9.5
Finsterer	1907	800	48	6.0
Bloodgood	1908	694	14	2.0
Rodman	1911	5,000	—	2.7
Geist and Wilensky	1915	558	22	3.9
Deaver and McFarland	1917	534	11	2.1
Bohdenburg	1917	276	6	2.1
Winslow	1921	102	3	2.94
Pack and LeFevre	1930	2,821	18	0.64
MacCarthy	1933	7,763	28	0.36
Fox	1934	3,509	60	1.7

made the ensuing situation less of a maze if it had been adhered to by subsequent authors. Gross divided his sarcomas into three principal varieties, the spindle-cell, the round-cell, and the giant-cell types, with the two former being subdivided into large- and small-cell types. Four years later, Poulsen reported thirty-three sarcomas and to illustrate the wide variety of terms used, his classification is included (Table III).

Small wonder that, with this extensive nomenclature, one author knew not of what another wrote. At the other extreme, we find that Ewing, in referring to the pure sarcoma of the breast, has written: "When one excludes from the group of mammary sarcomas, the adenosarcomas, the malignant forms of mixed tumor containing cartilage, bone, mucoid or fat tissue, and certain malignant round, spindle, and giant-cell alveolar pseudosarcomas, which are really atypical carcinomas, there is little remaining of a once formidable group of neoplasms." He further stated that the only two varieties of pure sarcoma that he recognized are the spindle-cell and the round-cell types. In addition, Ewing considered the latter to be an ill-defined group and stated that they may really be only atypical carcinomas.

TABLE II

FREQUENCY OF SARCOMATOUS LESIONS REPORTED IN THE LITERATURE

AUTHORS	YEAR	TOTAL NEOPLASMS STUDIED	SARCOMAS	
			NUMBER	PER CENT
Rosenstein	1901	171	9	5.3
Geist and Wilensky	1915	282	22	7.8
Peck and White	1922	195	4	2.1
Smith and Bartlett	1929	234	7	3.0
D'Aunoy and Wright	1930	1,046	11	1.1
Schreiner and Thibaudeau	1932	1,395	7	0.5
MacCarthy	1933	3,517	28	0.8
Schwarz and Freund	1935	1,145	20	1.8
Rose	1936	660	16	2.4

TABLE III
DIAGNOSIS AND CLASSIFICATION ACCORDING TO POULSEN

DIAGNOSIS	CASES
Cystosarcoma	14
Fibrosarcoma fusicellulare	3
Fibrosarcoma globocellulare	1
Sarcoma fusicellulare	3
Sarcoma globocellulare	1
Sarcoma globo-et-fusicellulare	3
Sarcoma carcinomatodes	1
Grosszelliges Pigmentsarcom	1
Adenosarcoma	3
Sarcoma	3

Grossly, all true sarcomas of the breast have a sameness of appearance in the initial stages of their development. The majority are rather well encapsulated, round, irregular or slightly lobulated, and lying in or next to the glandular structure. At an early stage, they are not attached to the skin or pectoral muscle and, consequently, can be rather easily "shelled out" in many instances. Pure sarcoma reaches a huge size infrequently, in distinct contrast to the malignant lesions which originate in the fibroepithelial neoplasms. The nipple usually is not retracted. On cross section, the color of the new growths varies from a gray-white to a gray-red, and the neoplasms are of moderately firm consistency.

The chief representative of the pure type of sarcoma is the fibrosarcoma or spindle-cell type. It is usually well demarcated from the breast tissue and may be surrounded by a layer of atrophic ducts and acini. On microscopic study of the sections, numbers of fusiform cells are seen lying in close apposition (Fig. 1) and forming strands that run in different directions, frequently interlacing. Cut in transverse section, these spindle-shaped elements are small and round and possess a nucleus that is relatively large and ovoid and has a well-defined network of chromatin. Mitotic figures are present in varied amounts and blood vessels may be relatively frequent. The regular arrangement of the neoplastic cellular elements about the blood vessels in some of these tumors has caused some of the earlier authors to err and consider them to be angiosarcoma, or angiosarcoma and perithelioma. A small amount of fibrillated matrix is found between the cells proper.

Before proceeding to a consideration of other types of sarcoma which may be found in the breast, it is important to point out that the great majority of the fibrosarcomas in this series had their origin in fibroadenomas and therefore have been designated adenofibrosarcoma. The enormous tumors of this category are those in which the epithelial elements have remained active and in which dilatation of the ducts and acini have resulted in cystic formations of varying sizes (Fig. 2). Usu-

ally the patient relates that a mass has been present in the breast for a long time, perhaps years, and that it suddenly has increased in size rapidly. Such tumors are irregular, nodular, and lobulated, frequently complicated by hemorrhage, necrosis, and ulceration. From the time of its inception, the growth has a tendency to be somewhat circumscribed and, although it may become large, it still retains this characteristic. In addition, it may be freely movable on the thoracic wall.

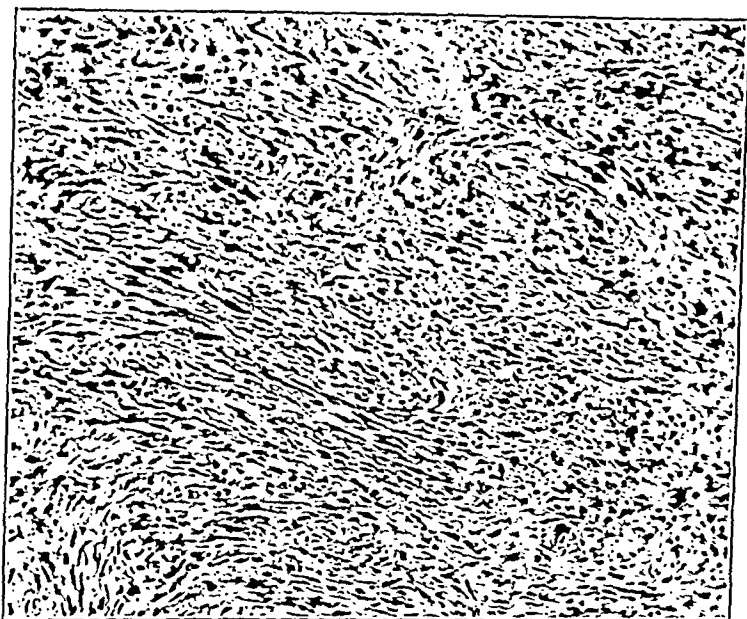


Fig. 1.—Pure fibrosarcoma of the mammary gland, Grade 1, with myxomatous change ($\times 150$).

The term "round-cell sarcoma" has persisted in the literature in spite of its recognized inadequacy, for the title is but purely descriptive of the morphologic characteristics of the cells present and gives absolutely no information as to the histopathogenesis of the neoplasm. These sarcomas form an ill-defined group and should not be included under the category of pure sarcoma of the breast. Careful study of many of these cases proves that a large number are merely atypical carcinomas. Lymphosarcoma has been reported as being present in the mammary gland, and a certain number of the "round-cell" group may be of that nature. In the latter group the question of whether the tumor is metastatic or not is not implied in the term "round-cell sarcoma." Ewing stated that he never had seen a primary lymphosarcoma of the mammary gland.

However, round-cell sarcoma of the breast has been described many times and, according to the literature, it is round, smooth, soft, and usually single, although occasionally multiple. It may appear in one or

both breasts, is of comparatively rapid growth, and infiltrates to a greater extent and is much more malignant than the spindle-cell sarcoma. The cells are round or oval in shape, have large nuclei, and may show a radial arrangement about the blood vessels. Geist and Wilensky concluded that since they were unable to find lymphoid tissue in the breast and since lymphosarcoma does not occur primarily in the gland, these neoplasms are undeveloped connective tissue tumors. Fox has avoided the term "round-cell sarcoma" entirely and has substituted the terms "lymphoid sarcoma" and "myeloid sarcoma," the former referring to the small round-cell type, and the latter designating the large round-cell group. He further stated that these tumors may arise from lymphocytes within the breast or from outlying glands. The myeloid sarcomas consist of round cells with large nuclei which have more cytoplasm and are lighter staining than the cells of the lymphoid type.

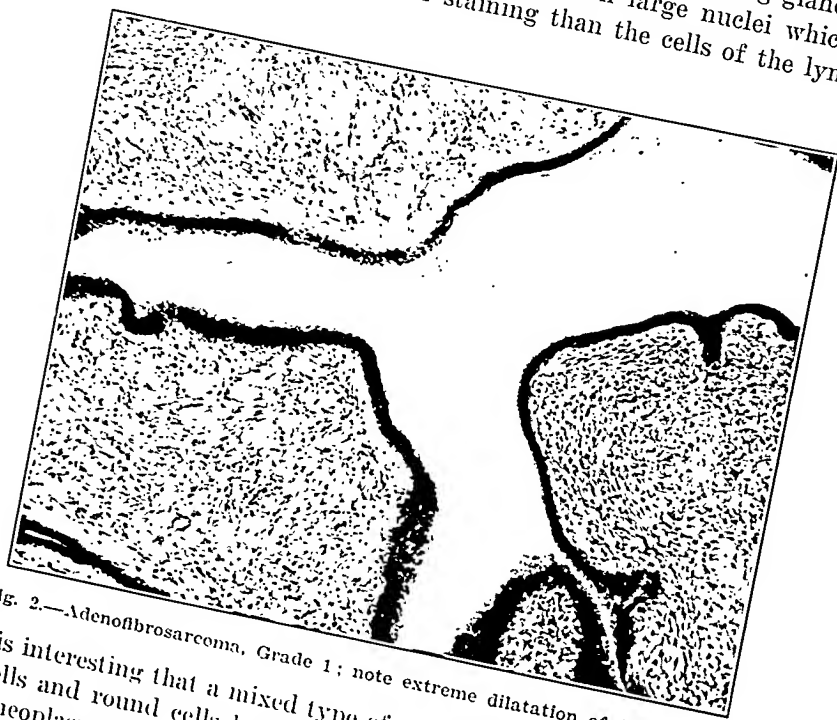


Fig. 2.—Adenofibrosarcoma, Grade 1; note extreme dilatation of ducts ($\times 80$).

It is interesting that a mixed type of tumor which contains both spindle cells and round cells has also been described. The exact origin of these neoplasms is still unsettled.

The wide diversity of tissue which may be found in the mammary gland was realized about a century ago by Cooper, for he stated then that all the changes which occur in other tissues can occur in the breast and that, in addition, some changes are peculiar to it. The presence of cartilage and bone in the breast has continued to be of interest to pathologists, and in 1937 Raso was able to collect seventy-four cases and add one of his own in which these tissues were present. Although Cooper

is credited by Raso with having first described such a neoplasm, perhaps the distinction really belongs to Morgagni (1682-1771), of Forlì, a pupil of Valsalva and later a professor at Padua. In his seventy-ninth year, he published five books of letters, which are seventy in number. They are the conclusions drawn from a lifetime of observation, and among these interesting and instructive epistles, which constitute one of the true foundations of modern pathologic anatomy, we find a description of one of these cases:

"There was at Padua a nun who had begun, thirty years before, first to labour under tubercles within one of her breasts, which lay at a distance from each other. These tubercles, at length, seem'd to be join'd together into one tumor, in the inferior part of the breast; and had such an inequality of surface, and excited such pains, that made it be universally consider'd as cancer. Last of all, the pains being greatly increas'd, the tumor open'd of itself. Then from the manner of its opening itself, from the nature of the matter discharg'd, and from the other appearances, an ingenious and skillful surgeon judg'd it not to be cancer, and undertook to cure it.

"However, the cure never proceeded according to his wish, or expectation, till about the end of the year 1739; when he extracted from the tumor a tuberous body, of the bigness of a walnut, which he brought to me. This body consisted of many little pieces of bone, some larger, some smaller, dispos'd in no certain or regular order, as I have seen them in the cases of fracture. Betwixt the pieces was interpos'd a substance almost similar to a ligament. This substance, when dried, grew black; but the bony fragments show'd their whiteness. The breast was therefore heal'd up; and although the exulceration return'd, the virgin did not die thereof, but of quite another disease, and at the end of three years after the extraction of that bony body."

In the main, three hypotheses have been advanced for the explanation of the origin of these teratoid mixed tumors. According to the hypothesis of sequestration, this neoplasm may be regarded as an aberrant blastomeric inclusion from the developing thoracic skeleton. St. Arnold, after describing a spindle-cell sarcoma containing bone, cartilage, and giant cells, wrote that spindle cells are in the same lineage as the individual units of the skeletal system, especially of the periosteum, and that they retain the fundamental capacity of forming cartilage and bone. Metaplasia does not occur and is an unnecessary hypothesis. Lecene concurred with the idea advanced by St. Arnold, and both concluded that such neoplasms arise as a result of misplaced portions of the skeletal system. The early encapsulation of these tumors favors this view, as do the wide diversity and fully adult character of the tissues produced.

Somewhat similar basically is the hypothesis advocated by Dyke who preferred to regard such neoplasms as the result of a totipotential cell which becomes imbedded in the mammary tissue early in embryonic life, and so considered them teratomas. The criticism that the latter should be composed of a mixture of cells derived from the three germ layers and therefore the tumor under consideration which contains

mesodermal elements only is not a teratoma can be refuted. It is not an unusual experience for any pathologist to encounter a tumor which contains derivatives of the three fundamental layers, but in which one type of cell has proliferated to a far greater extent than any of the others. This statement is much more correct if malignancy supervenes in one group of these cells. An outstanding example of such a change is the demonstration of a chorionepithelioma in a testicular teratoma. The chorionepithelionic elements rapidly outgrow the elements of the testicular teratoma, and it may be difficult at times to find the latter.

A third explanation offered for the origin of chondrosarcoma, osteosarcoma, and combinations of the two is that of fibroblastic formation of cartilage and bone. The fibroblasts are an undifferentiated type of cell and retain the fundamental power of becoming differentiated into cartilage and bone. Ewing has been an advocate of the autochthonous hypothesis, and wrote that the local development of mixed mammary tumors by a process of metaplasia may have to be accepted.

Reports of "giant-cell sarcoma" are occasionally encountered in the literature. A small number of spindle-cell sarcomas and other tumors of the breast contain giant cells and, because of this morphologic peculiarity, have seemed to merit the aforementioned designation. When present, they may be extremely numerous, and may be of three different types. In one group only two or three nuclei are found in each cell, and these comprise the multinucleated tumor giant cell. A second type of tumor giant cell is that with a single giant nucleus which almost fills the cell body. Multinucleated foreign body giant cells may also be found in the sarcomas. A better nomenclature and less confusion would result if sarcomas containing such cells were designated, for example, as spindle-cell sarcomas with giant cells, rather than as "giant-cell sarcomas." At this juncture, it is also well to remember that these multinucleated cells may appear in other types of malignant and nonmalignant neoplasms and that giant cells may be either of the neoplastic or foreign body type.

Multinucleated tumor giant cells probably arise from continued nuclear division in malignant cells without subsequent splitting of the cellular body. The origin of the foreign body giant cell may be similar or it may result from a coalition of individual endothelial cells.

In reporting a giant-cell neoplasm which also contained osteoid tissue, Fry referred to this tumor as an osteoclastoma. He justified the use of this name by the fact that a large number of giant cells of the epulis type are present. The apparently similar morphology and function of the giant cells in this tumor and in a myeloid sarcoma seem to afford the author sufficient reason for use of the term. These cells may be essentially of the foreign-body type developed in response to a local stimulus and their function in Fry's tumor is to attack the material in which bone or lime salts are deposited. The continued presence of this stim-

ulus leads to an overproduction of the giant cells and subsequently the latter become malignant and form the essential feature of the neoplasm. It should be noted, however, that the stimulating feature is not confined to cartilage and bone, but also includes carcinoma, tumors with other epithelial elements, and even chronic cystic mastitis, for giant cells have been found in all of these cases. As with spindle-cell sarcomas which contain these interesting elements, better usage of terminology would be to designate such neoplasms as osteochondrosarcomas with giant cells or carcinomas with giant cells, rather than as "giant-cell tumors."

It is interesting to note that in neoplasms in which considerable destruction has taken place, the giant cells may be of the true foreign body type and are merely present to remove the debris. Fat necrosis of the breast is an excellent example of this reaction, and the same process may be found in the sarcomas of the breast.



Fig. 3.—So-called perithelioma; this is an adenofibrosarcoma showing extensive necrosis but with perivascular malignant elements preserved ($\times 85$).

The remaining types of mammary sarcomas are few in number and all are somewhat rare. Among the latter is the liposarcoma which usually arises from a pre-existing lipoma. Histologic investigation reveals an embryonic type of adipose tissue cell with multiple, small fat globules and centrally disposed nuclei. Enough fat is usually present in the cells to enable the observer to recognize the lipomatous nature of the tumor, especially when stained with sudan III. When the fat content is reduced to traces, a diffuse growth of either large granular cells or smaller, rounded polyhedral cells is present.

In general, they may be considered of a low grade of malignancy. Usually, they possess a well-defined capsule, are of slow growth, and are freely movable. However, a marked tendency to recur is one of their characteristics, and occasionally metastatic lesions will be found.

A word of caution in regard to the diagnosis of these tumors should be added. Immature fat cells are frequently abundant in rapidly growing lipomas. They merely represent the means of growth, for adult fat cells do not have the power to proliferate. Hence, a distinction may be made with difficulty at times.

Brief consideration also should be given to another unusual neoplasm, the angiosarcoma. Karsner might restrict the use of the name to some extent for he has considered that "the use of the term angiosarcoma has little justification on morphologic or genetic grounds, as the tumors to which it is applied are either sarcomata with secondary necrosis, or endotheliomata of particular form." Peritheliomas, which are also included in this group, are usually likewise only vascular sarcomas which show widespread necrosis with perivascular preservation of the malignant elements and are not true entities (Fig. 3).

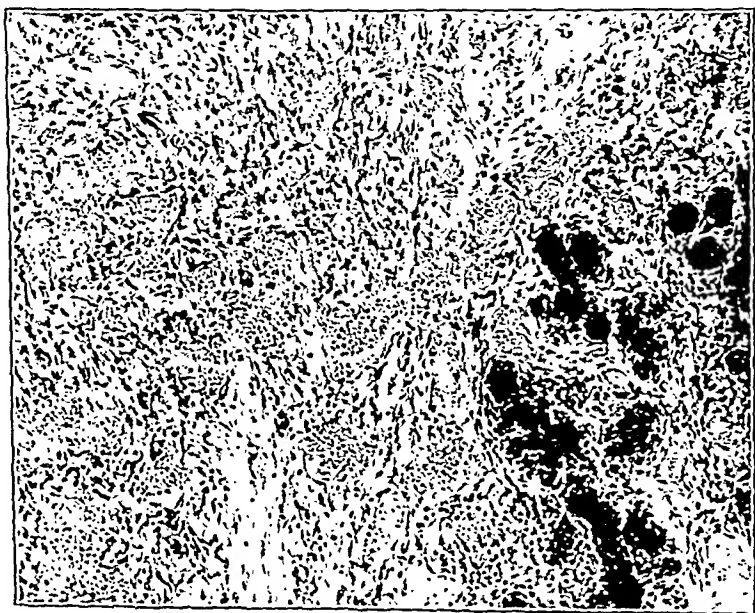


Fig. 4.—Hemangioendotheliosarcoma (X125).

However, the hemangioendotheliosarcoma is a neoplasm which is of vascular origin. Growth is slow, but progressive, and in this respect it is comparatively benign. Due to its infiltrative power, removal is difficult, so that this neoplasm is noted for its persistent local recurrence. Each of these reappearances is likely to show increasing capacity for growth and changes in structure.

These facts are well illustrated by the case of a 38-year-old unmarried female who had had a portion of her left breast removed before coming to the clinic because of a "fibroid tumor." However, this neoplasm (Fig. 4) which subsequently was found to be a hemangioendotheliosarcoma, recurred eight times in all, until the patient succumbed to the disease.

The third type of the more unusual sarcomas of the breast is the leiomyosarcoma, and an extremely occasional occurrence might be expected because the mammary gland contains a small amount of smooth muscle in the nipple, in the walls of the blood vessels, and in a single layer of longitudinally arranged involuntary muscle between the basement membrane and the adjacent layer of connective tissue. The elastica surrounds the latter in all the ducts and some of the acini, and external to the elastica is a thicker layer of unstriated muscle. Dretzka reported a neoplasm of the mammary gland in which many immature muscle cells were present. One of the opinions submitted was that it was a leiomyosarcoma.

In contrast, the tumors of voluntary muscle are somewhat more frequent in appearance. Early mention of a rhabdomyosarcoma was made by Billroth, in 1860, when he reported a neoplasm of this character in the breast of a 16-year-old female. Definite striated muscle was found in this tumor. Subsequently, additional cases were reported and commented on. These new growths include both encapsulated and non-encapsulated forms and are composed of cells with a granular cytoplasm, small dense nuclei, and ribbon-like bands of muscle fibers. Cross-striations may or may not be found, depending on the degree of differentiation of the cells. It will be recalled that voluntary muscle passes from a syncytial stage in the mesenchyme to a myoblastic and then to a myofibrillar stage. At this point, the developing muscle fibers first show beading and then cross-striations. Thus, the more undifferentiated type of rhabdomyosarcoma, the myosarcoma, shows a wide variety of phases of histogenesis.

Klinge also found such tumors in situations devoid of striated muscle and he explained these heterotopic myoblastomas by Cohnheim's hypothesis. Gray and Gruenfeld, in discussing the subject, added a note of warning, and questioned the myogenous derivation of these tumors, as they considered unwarranted a histogenic diagnosis based on some vague resemblance of cells which also may exhibit conspicuous degenerative changes.

However, the diagnosis of the case reported by Sailer must be unquestioned. A nodule the size of a bean was removed from the breast of a 38-year-old colored woman, but recurrence was noted in the scar seven months later and the patient eventually died. Post-mortem examination revealed metastatic nodules in the lungs, liver, and retroperitoneal

lymph nodes. All of these lesions were composed of elongated, striated muscle fibers, myoblasts, and small, irregularly round and polyhedral cells.

Lymphosarcoma of the breast is an interesting and unusual pathologic entity. Whether such a new growth is ever primary in the breast has been a moot question, for lymphoid tissue does not occur in the normal breast. It may be that these neoplasms arise from lymphocytes which have wandered into the gland, from adjacent lymph nodes, from collections of lymphocytes which are a result of chronic mastitis and in which condition they are so commonly and almost constantly seen or are metastatic deposits.

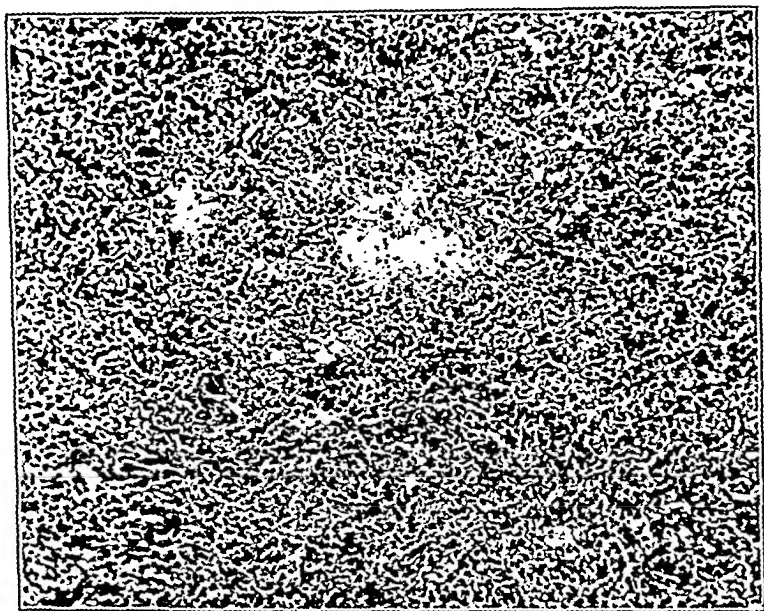


Fig. 5.—Lymphosarcoma ($\times 130$).

Deposits in the breast have been reported in cases of chloroma, with and without blood changes, in lymphatic leucemia, lymphogranuloma of the Hodgkin's type, and lymphosarcoma. Three types of disease may be present: (1) that in which involvement of the breast is merely part of a generalized process; (2) the less frequently appearing cases of an apparently localized lymphogranulomatous neoplasm which is subsequently found to be part of a systemic disease; and (3) localized lymphogranuloma and lymphosarcoma.

In the present series of sarcomas two cases of lymphosarcoma have been found. One patient had a mass in both breasts and she subsequently was found to have a generalized process. Radical amputation of the left breast for a malignant lesion was performed in the second case and microscopic study has shown this to be a lymphosarcoma (Fig. 5).

Two other malignant lesions of the breast should be briefly mentioned. According to Fox, the neurogenic sarcomas have their origin in the nerve sheaths. The neoplastic cells are varied in size and shape and neither a perithelial nor a periductal arrangement is seen. Tumor giant cells and huge multinucleated cells may be found; hemorrhage and necrosis are frequent. Schultz-Brauns, writing in the handbook of Lubarsch and Henke, was able to find but three cases reported in the literature and he added that these are all doubtful and that a true neurosarcoma of the breast probably does not occur. The term itself is somewhat misleading, and these tumors, if they do exist, should be called fibrosarcoma, with the qualification that they originate from nerve sheaths.

Malignant melanoma of the breast has been reported on several occasions as a carcinoma, and on others, as a sarcoma. Because of the controversy as to their origin and the fact that intramammary melanomas are probably of a secondary nature, we shall limit our consideration of them.

Thirty-six patients who had various types of sarcoma and one patient who had a mixed type of tumor (carcinoma and sarcoma combined) comprised the group studied. The pathologic diagnoses are presented in Table IV.

TABLE IV
PATHOLOGIC DIAGNOSES IN THE CASES STUDIED

DIAGNOSIS	CASES
Adenofibrosarcoma	23
Adenochondrofibrosarcoma	1
Fibrosarcoma	9
Hemangioendotheliosarcoma	1
Lymphosarcoma	2
Mixed tumor	1

In one of the cases of adenofibrosarcoma and in four of the cases of fibrosarcoma operation had been performed elsewhere before they were encountered for the first time at the clinic. Table V consists of a brief summary of the various types of pathologic changes encountered by

TABLE V
SARCOMA OF THE BREAST; PATHOLOGIC CHANGES ENCOUNTERED BY VARIOUS AUTHORS

AUTHORS	YEAR	TOTAL CASES SAR- COMA	FIBRO- SARCOMA		ROUND- CELL SARCOMA		CYSTO- SARCOMA		GIANT- CELL SARCOMA		ADENO- SARCOMA	
			NUM- BER	%	NUM- BER	%	NUM- BER	%	NUM- BER	%	NUM- BER	%
Gross	1887	156		68		27				5		
Gebele	1901	34	11	68	5	14	7	20	2	6		
Finsterer	1907	40	10	25	6	15	18	45				
Geist and Wilensky	1915	22	5	22	4	18	4	18	2	9	26	6
		435*	136	31	62	14	54	12				
Fox	1934	60	42	70					2	3		

*Total collected cases.

various authors in studies of sarcomas of the breast. Twenty-four of the thirty-three cases of fibrosarcoma (73 per cent) had their origin in adenofibroma, and thus are correctly designated as adenofibrosarcoma and in one case as adenochondrofibrosarcoma. The relatively high incidence of sarcoma arising in adenofibroma is not generally appreciated. Round-cell sarcoma was not found at all.

Tumor giant cells were found in eleven of the specimens studied. Of these, six were adenofibrosarcoma, one was adenochondrofibrosarcoma (Fig. 6), three were fibrosarcoma and one was the mixed growth. One of the fibrosarcomas also contained multinucleated foreign body giant cells.

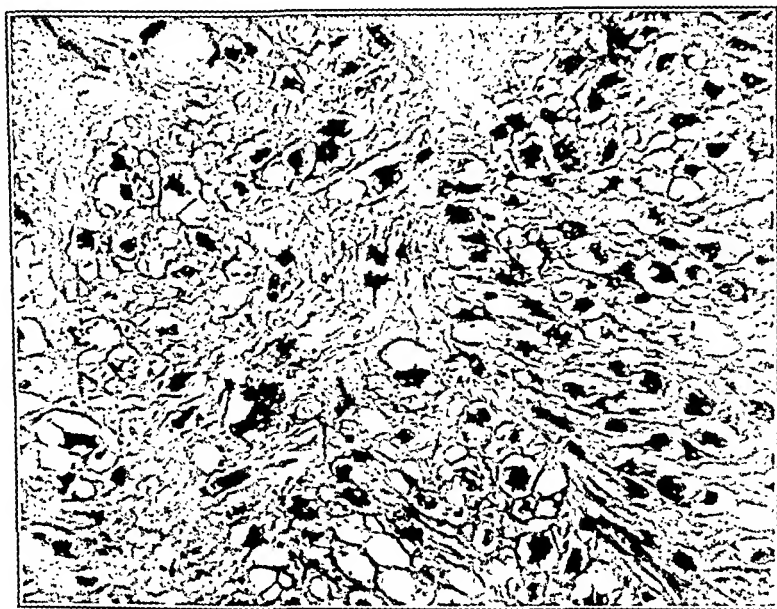


Fig. 6.—Adenochondrofibrosarcoma ($\times 250$).

In marked contrast to carcinoma of the breast from which regional metastasis to the lymph nodes is fairly frequent, not one of the patients studied showed such involvement. In eight cases, the axillary lymph nodes, and in one, the supraclavicular lymph nodes were enlarged on clinical examination, but microscopic study revealed all to be of an inflammatory character. Geist and Wilensky found that, in thirteen (3 per cent) of a total of 435 collected cases, malignant involvement of the regional lymph nodes occurred.

CONCLUSIONS

1. Thirty-six sarcomas of various types and one mixed tumor comprised the total series.
2. In twenty-four of the thirty-three cases, the fibrosarcomas (73 per cent) had their origin in adenofibromas.

3. Genetically and practically, neoplasms of such an origin are properly designated as adenofibrosarcoma.

4. The use of the term "round-cell sarcoma" is antiquated and obsolete, and it does not have a place in the nomenclature of the neoplasms under consideration.

5. Likewise, the employment of the expression "giant-cell sarcoma" is fallacious and misleading and does not serve a practical advantage, as the fundamental pathologic character of the neoplasm is not thereby suggested.

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ISOTONIC AQUEOUS IODINE SOLUTION AS A SKIN ANTISEPTIC

A CLINICAL APPRAISAL

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INTRODUCTION

THE properties and effectiveness of iodine, an aqueous solution containing 1.85 per cent free iodine and 2.189 per cent of its sodium, calcium, and potassium salts, as a skin antiseptic have already been studied from an experimental standpoint.

In a comprehensive study of 34 commonly used skin antiseptics Allen, Moorehead, and Edgerly¹ found that more uniform bactericidal action was exhibited by iodine solutions and by merthiolate 1:1,000 than by any of the other solutions tested, using Wright's method. In skin sterilization tests isotonic aqueous iodine solutions and merthiolate 1:1,000 again proved uniformly superior, both to all other antiseptics and to other iodine solutions in different strengths and different solvents. The superiority of aqueous iodine as compared to various commercial solutions and to varying dilutions of standard antiseptics also was demonstrated by Nye² in a series of in vitro experiments.

Karns and his associates^{3, 4} have conducted detailed studies of iodine solutions in different solvents and in varying strengths. They showed that most of the undesirable effects of iodine solutions are "due to a lack of adjustment of the dose between the amount of the active agent required to give adequate antisepsis and that causing tissue destruction." Karns also demonstrated that the wetting and staining power of iodine in aqueous solution is not only greater but more uniform than in alcohol or glycerol solutions, and that an exact dosage could be delivered to the painted surface. On this basis he evolved a formula for the preparation of an aqueous solution of iodine and its sodium, potassium, and calcium salts in approximately the same ratio of each component as they occur in the blood. This, of course, can be made up in any strength, preserving the ratio of each component, and he found that the optimum strength was 2 or 3 per cent (free iodine) depending on whether the surface to be painted was skin or mucous membrane. The 3 per cent solution was shown, in experiments on guinea pigs and on the human skin, to have a greater staining and penetrating power than any other solution tested. Biskind^{5, 6} also demonstrated the greater speed of penetration of isotonic aqueous

iodine solutions, but he found that the tanning effect, and consequent reduction of permeability, on frog's skin was about the same for the aqueous solution as for the 7 per cent tincture.

Thus, the experimental background for the use of isotonic aqueous iodine solution as a skin antiseptic has been thoroughly established, but it has not been subjected to a critical analysis of its clinical suitability for the preoperative preparation of the skin, and it was for this purpose that the present study was undertaken.

Secor⁷ has reported very satisfactory results with the use of aqueous iodine solution in hospital work, but does not record a detailed analysis of his methods or findings. It is apparent that any such clinical evaluation must be, at best, to a large extent empirical, but every effort has been made, in the present study, to approximate as closely as possible the accuracy of laboratory experimentation.

It was felt that the most logical approach would be a comparison with a standard mercurial skin antiseptic and with an aqueous iodine solution (Lugol's solution diluted to 1.55 per cent iodine and 3.7 per cent potassium iodide content) not ordinarily used for this purpose, but resembling in some respects the product under scrutiny.

The criteria for study and comparison were as follows:

1. Bacteriocidal and bacteriostatic effect in actual use at the operating table.
2. Advantages and disadvantages as to ease and smoothness of application, quantities required, and the like.
3. Delayed secondary effects, such as skin irritation, burns, desquamation, etc.
4. Personal impression of the various surgeons cooperating in the study by using the preparations under investigation.
5. Cost of the various preparations.

METHOD

Two hundred and sixteen consecutive operative cases were used in the study. These were routine surgical and gynecologic patients in the operating rooms at the Cincinnati General Hospital and were unselected, except that only "surgically clean" ones were included. Abscesses, empyema, osteomyelitis, and similar infected cases were not included for obvious reasons. With these exceptions, patients were taken in chronological order and divided into alternate weekly periods. Isodine was used in the preparation of the skin on all cases for one week, and, by turn, merthiolate, a mercurial antiseptic, was used the following week. The investigation extended over a period of three months. Because dilute Lugol's solution is of dubious value as a skin antiseptic, it was not considered safe for use in the main operating rooms. A small series of minor surgical cases in the Out-Patient Clinic was employed to conduct a parallel study of this iodine solution.

TECHNIQUE

A cotton swab culture (the swab dipped in sterile normal saline solution) was taken from the operative field after simple cleansing of the skin with soap and water, alcohol, and ether, a procedure which is routine for all operative cases on our surgical divisions, regardless of the skin antiseptic used. A second swab culture was taken from the same area after application of the skin antiseptic. Then, after the field had been draped, a small fragment of skin was taken, either from the edge of the incision or from the immediately adjacent skin. All specimens for culture were placed in dextrose-ascites broth at once (No. 1 in 10 c.c. and Nos. 2 and 3 in 150 c.c.) and transferred immediately to the incubator. All swabs used for taking the swab cultures were especially prepared for uniformity of cotton content, and the technique of taking the cultures was approved by one of the bacteriologists (Dr. G. E. Gerwe) collaborating with us.

The samples were incubated seven to ten days at 37° C., and daily examinations were made for appearance of any contamination. At the end of the incubation period, all noncontaminated samples were inoculated with 0.1 c.c. of a 1:100 dilution of twenty-four-hour pure culture of *Staphylococcus aureus* (certain exceptions will be noted later). It was found, after this procedure, that a certain number of samples from the Culture 2 series still failed to show growth. It was apparent that this must be due to the bacteriostatic action of the skin antiseptic, enough of it having been carried over on the swab from the painted skin surface to inhibit growth of the direct inoculation. The media in these samples were then diluted to various degrees with distilled water and reinoculated with *Staphylococcus aureus*. Details of this special study will be presented below.

All cases were followed postoperatively for wound infections, burns, skin irritations, desquamation, and similar untoward effects.

The 216 cases used for the study were operated upon by fifteen different surgeons, and the personal impressions of these men with regard to the comparative advantages of the three solutions were solicited and recorded.

DATA AND OBSERVATIONS

1. *Bacteriologic Studies.*—The total number of samples examined and the number of contaminations are tabulated in Table I.

Several inferences may be drawn from this table. First, that so far as can be determined by the swab culture method, simple cleansing of the skin with soap and water, alcohol, and ether is fairly effective, since only 49 (22.6 per cent) of the 216 cases showed any contamination after this routine procedure.

TABLE I

SAMPLES	TOTAL NUMBER OF CASES	NUMBER OF CONTAMINATIONS		
		NO. 1 (SWAB FROM WASHED SKIN IN 10 C.C. OF BROTH)	NO. 2 (SWAB FROM PAINTED SKIN IN 150 C.C. OF BROTH)	NO. 3 (SKIN FRAGMENT IN 150 C.C. OF BROTH)
Merthiolate	111	24 (21.6%)	0	23 (20.7%)
Dilute Lugol's 1.85% iodine	11	1 (9.0%)	0	3 (27.2%)
Isodine 1.85% iodine	94	24 (25.5%)	14 (14.9%)	28 (29.7%)
Total	216	49 (22.6%)		

Second, that none of the solutions is very effective on the deeper skin structures (penetration into hair follicles and sweat and sebaceous ducts) since a high percentage of all cases showed contamination from the skin fragments and the percentage was about the same for all types of skin antiseptic. It is worth noting here, also, that the amount of solution transferred to culture media in this series is minimal as compared to that absorbed and carried over on the swab in Series 2. This fact may explain in part the increased contaminants in Series 3 as compared to Series 2. It is, of course, common knowledge that no skin antiseptic is very effective against deeply lying organisms and the present series is too small to warrant any conclusion regarding the penetrating power of the three solutions. As was indicated above, this point already has been investigated.

Third, it would appear at first glance that both dilute Lugol's solution and merthiolate are considerably more effective on the surface, since none of the samples in Series 2 showed any contamination with these solutions, while 14 (15.5 per cent) of this same series, using isodine, showed contamination. A further analysis of the results, however, throws additional light on this point.

Table II represents a complete tabulation of all of the cases of Series 1 and 2 of the isodine group which showed contamination.

It becomes apparent that only 4 of the 14 cases in which No. 2 was contaminated had originally shown contamination in No. 1, suggesting failure of the isodine to sterilize the skin.

The remaining 10 cases in Series 2 were cases where there had been no growth after the original routine washing, suggesting either that organisms present were missed by the swab in Culture 1 or that positive cultures in Series 2 of these cases might represent outside contaminants. Since these 10 cases must remain equivocal, in only 4 of the 94 cases in which isodine was used can it be argued with reasonable plausibility that the antiseptic had failed to sterilize the skin, and this compares more favorably with the results where merthiolate was used.

It will be recalled that in the whole series all negative samples were reinoculated with 0.1 c.c. of a 1:100 dilution of a twenty-four-hour pure culture of *Staphylococcus aureus*. This practice was abandoned

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TABLE III

RESULTS AFTER REINOCULATION IN THE NEGATIVE CULTURE SERIES 2 OF ALL THREE SOLUTIONS TESTED

	NUMBER REINOCULATED	POSITIVE AFTER REINOCULATION	NEGATIVE AFTER REINOCULATION
Merthiolate	99	31 (31.3%)	68 (68.6%)
Isodine	75	75 (100.0%)	0
Dilute Lugol's	10	9 (90.0%)	1 (10.0%)
Total	184		

showed growth. We do not believe, however, that this indicates greater fallibility on the part of the latter solutions. The more uniform and rapid drying power of aqueous iodine solutions has already been demonstrated by other investigators (Karns and co-workers). It was noted in the course of our study that, although the samples bore no identifying labels to indicate what skin antiseptic was used, the merthiolate samples were almost always recognized by the bacteriologist by their pink color (eosin), while the other samples showed no discoloration. This would imply that, because the aqueous iodine solution dries more rapidly and uniformly, much less solution was carried over into the culture than that absorbed by the swabs applied to the still wet merthiolate painted surface.

To follow up this point, a separate dilution study was carried out. The amount of merthiolate absorbed by the swabs being highly variable, a series of samples was selected according to depth of color, assuming that the deeper the color (eosin) the more merthiolate had been absorbed on the swab. To each sample selected distilled water (sterile) was added in given amounts and inoculation was repeated, as indicated, and the samples reincubated, with readings at twenty-four and forty-eight hours. The information sought is tabulated in Table IV.

TABLE IV

CASE NO.	DISTILLED WATER	24-HOUR STAPHY. AUREUS	GROWTH IN HOURS	DEGREE OF COLORATION OF SAMPLES
88965	10 c.c.	1 c.c.	24	Very faint pink
89076	15 c.c.	1 c.c.	48	Medium pink
88781	20 c.c.	1 c.c.	0	Not very deep
88497	25 c.c.	1 c.c.	0	Not very deep
88911	30 c.c.	1 c.c.	48	Light pink
88314	35 c.c.	1 c.c.	48	Light pink
88905	40 c.c.	1 c.c.	0	Very deep pink

It becomes evident, then, that the apparent high degree of effectiveness of the merthiolate solution, as compared to that of isodine, was more probably due to the greater amount of merthiolate absorbed on the swab in making the original cultures.

It seems fair to conclude, therefore, that in bacteriocidal and bacteriostatic action the two antiseptics are of about equal value. This is in agreement with the findings of Allen, Moorehead, and Edgerly.

TABLE II
ISODINE GROUP
CONTAMINATIONS IN SERIES 1 AND 2

CASE NO.		INCUBATED SAMPLES	
		1	2
1.	88040	+	-
2.	88335	+	-
3.	83707	+	-
4.	88727	+	-
5.	88754	+	-
6.	88704	+	+
7.	88676	+	-
8.	88619	+	-
9.	88618	+	-
10.	88614	+	-
11.	88583	+	-
12.	88690	+	-
13.	88728	+	-
14.	88523	+	-
15.	89267	+	+
16.	88391	-	+
17.	89286	+	-
18.	89277	+	-
19.	89358	-	+
20.	89527	+	-
21.	89786	-	+
22.	89779	-	+
23.	89929	-	+
24.	89896	-	+
25.	89548	+	-
26.	89983	+	-
27.	91626	-	+
28.	91574	-	+
29.	91551	+	+
30.	91730	+	-
31.	91574	-	+
32.	93033	+	+
33.	93242	+	-
34.	93187	-	+

Total contaminations No. 1 only 20

Total contaminations No. 1 and 2 4

Total contaminations No. 2 only 10

Total contaminations 34

on the last 32 cases in the series, because the information sought already had been gained on the first 184 cases. These reinoculations showed growth promptly in 100 per cent of the samples from the washed skin, as would be expected, there being no antiseptic solution carried over to inhibit growth of the direct control inoculation. In Series 2, however, reinoculation showed the results given in Table III.

A study of this table suggests that the amount of merthiolate carried over on the swab into 150 c.c. of the broth exerted enough bacteriostatic action to inhibit growth completely in 68.6 per cent of the directly reinoculated samples, while with the other two solutions, 100 per cent and 90 per cent respectively, of the reinoculated samples

The principal objections to isodine, in order of emphasis, were (a) greater difficulty of application, (b) acrid and irritating odor, (c) poorer delineation of the painted area, and (d) occasional skin irritation.

5. *Cost of the Preparations.*—Here the tremendous advantage of isodine is obvious. The cost of preparation of isodine is but a small fraction of that of merthiolate. Although this is an important consideration, especially in large nonprofit hospitals such as the Cincinnati General Hospital, it was the general opinion of the group of surgeons consulted that they would prefer to pay the higher price for merthiolate because of the advantages, outlined above, which it offers.

CONCLUSION

It is our opinion that isodine is an efficient and satisfactory skin antiseptic for use in the preoperative skin preparation of surgical cases. In comparison with merthiolate, however, with the exception of the much more moderate cost of the former, we feel that its collateral disadvantages make its general adoption for this purpose unlikely.

Thorough washing of the skin with soap and water, alcohol, and ether was employed in all cases prior to the use of the antiseptics studied in this investigation.

REFERENCES

1. Allen, A. W., Moorehead, J. J., and Edgerly, M. P.: A Bacteriological Appraisal of Thirty-Four Commonly Used Antiseptics, *Am. J. Surg.* 23: 371, 1934.
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As collateral evidence, it seems pertinent to note at this point that only two wound infections occurred in the entire series. Both of these happened to be in cases where merthiolate had been used, and in both the infection was satisfactorily explained on the basis of factors unrelated to preliminary skin sterilization.

As might be expected, from the well-known character of the average skin contaminants, the organisms recovered from the test samples were as follows: *B. subtilis*, *B. pyocyaneus*, *Aerobacter aerogens*, *sarcina*, *Staphylococcus aureus*, *Staphylococcus albus* and nonhemolytic streptococcus. An analysis of the relative frequency of occurrence of the various organisms would contribute nothing to the problem under consideration.

2. *Physical Advantages and Disadvantages.*—In regard to the physical properties of the two solutions, isodine was found to be the more difficult to apply. If applied in minimal amounts, the sponge having been wrung out, a smooth coating was produced, but the process of application was slower. If larger amounts were used, with the sponge not wrung out, there was an annoying tendency for the solution to puddle and run off the skin and the excess had to be removed with a dry sponge, with resultant delay in preparation and draping of the patient. Merthiolate was found to paint smoothly regardless of the wetness of the sponge, thus eliminating the necessity of wringing the sponge or wiping off the excess.

It was also noted that the deeper color (eosin) of the merthiolate made the limits of the prepared skin area much more clearly defined.

A third disadvantage of isodine was the rather sharp acrid odor which was found to be extremely irritating to the eyes and to the nasal mucosa of the operator, inducing an annoying lachrymation in addition to the unpleasant odor.

3. *Delayed and Secondary Effects.*—From this standpoint, isodine is again at a slight disadvantage. No serious burns were encountered in any of the cases. In the merthiolate series no irritation of any sort occurred in any case. In the isodine series 12 cases showed slight desquamation in areas where adhesive tape had been applied over the painted surface. Of these 12, 11 had no discomfort and the desquamation was so slight as to be scarcely worth mentioning. In the twelfth there was itching and subjective irritation, and lanolin was applied for twenty-four or thirty-six hours with complete relief.

4. *Personal Impressions of the Fifteen Surgeons in Whose Cases the Solutions Were Used.*—These may be summarized briefly by the fact that merthiolate was universally preferred. Although isodine was found to be perfectly satisfactory from the standpoint of wound healing and efficiency as a skin antiseptic, all of the surgeons preferred merthiolate because of its ease and rapidity of application, efficiency, and clear delineation of the treated area.

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Editorial

The Conservative Treatment of Appendical Peritonitis

THERE is a great deal of controversy among surgeons concerning the advisability of immediate operation in cases of acute appendicitis. In spite of one's convictions concerning appendical disease, there can be no question that treatment of acute appendicitis is always surgical and should consist of immediate extirpation of the appendix before infection has extended beyond the confines of that viscus.

In appendicitis, as in other conditions, however, the presence of certain complications is of more importance in determining the type of therapy than the original lesion itself. This is particularly true in many cases of appendical peritonitis. Unfortunately, too many physicians consider the conservative treatment of appendical peritonitis as that of appendicitis and as a result of this there has been much confusion in the rationale of the therapy. As emphasized above, there is no conservative treatment of appendicitis; for, although in many cases of inflammatory disease of the appendix the infection will subside spontaneously without extension into the peritoneum, one is not justified in assuming that such will occur because of the consequences when it does not occur.

In cases, however, in which there has been perforation of the appendix with production of peritonitis, unless the perforation has occurred within a very short period of time, conservative therapy should be instituted. The rationale of such treatment is based upon the fact that most cases of peritoneal infection will localize if given a chance. The addition of an operative trauma to a patient who is critically ill with a spreading peritonitis may produce a fatal result. Also, the patient whose lesion is beginning to localize invariably will be harmed by an operative procedure before complete localization has occurred, because breaking protective adhesions in removing the appendix will result in a spreading of the infection and recontamination of the peritoneal cavity, in addition to the trauma imposed by the operation.

One of the reported disadvantages of the conservative treatment of appendical peritonitis has been that complications are more likely to occur. Being a staunch advocate of the method, I frankly admit that such is possible but that this is not necessarily undesirable. Complications are more likely to occur following institution of conservative therapy because patients live long enough to develop the complications. Instead of a patient's succumbing within three to four days after the operative procedure, the patient will develop a cul-de-sac, a subphrenic,

or other residual abscess a week or ten days later. The prompt recognition and the institution of adequate drainage in these complications, however, will result in a complete cure. The contention that the conservative treatment of appendical peritonitis is attended by a higher complication incidence is not borne out by the experience of the surgical clinic of Duke University in which the incidence of complications was lower than in those cases operated upon immediately.

It should be emphasized, however, that the institution of conservative treatment of appendical peritonitis is much more difficult and taxes the surgical judgment of even the experienced surgeon. It certainly is no method of treatment to be used by the occasional operator, and I, personally, am convinced that the physician who sees relatively few cases of peritonitis complicating appendicitis will do better by operating upon all such cases immediately, irrespective of the time that they are seen and the presence or absence of all complications.

—*Alton Ochsner.*

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

RECENT ADVANCES IN SURGERY OF THE ESOPHAGUS

CLARENCE E. BIRD, M.D., PROVIDENCE, R. I.

(Continued from the October issue)

CARCINOMA

In 1923, Fischer concluded an historical review on the subject of surgical treatment of carcinoma of the esophagus with the prediction that "not many years from now many cures will have been accomplished in a disease that was beyond help and hope." It is my purpose to indicate the extent to which this prophecy has been fulfilled during the past sixteen years.

The older writers were well aware of the fact that carcinoma originating in the esophageal mucosa is resectable, pathologically speaking, in a fairly large number of cases (e.g., Billroth, 1871). The likelihood of complete removal is greater than in carcinoma of the stomach, for example. More recent studies in the main have substantiated this view. Turner (1934) noted that in all five cases in which he had been able to complete the radical removal of the esophagus, there was no evidence of dissemination. He remarked that "in one notable case the patient lived for 19 months after gastrostomy or 21½ months after the first symptoms of esophageal obstruction, and even then death was precipitated by perforation with a bougie. A long linear growth at the lower end showed only local spread." Krauss (1933) mentioned a man who was thought to have an inoperable carcinoma in the lower third, but at autopsy six months later showed a small operable growth. Helsley (1923) studied 70 fatal cases at the Franz Josef Hospital in Vienna. Sixty-four per cent of the tumors were purely local, with no metastases to regional lymphatic nodes; only 6 per cent showed metastases to the nodes alone;* the other 30 per cent showed local and distant metastases. Among forty-nine necropsies at the Cook County Hospital in Chicago, 28.5 per cent of the tumors had not metastasized (Buchbinder, 1925). In fifty-one autopsy records at St. Bartholomew's Hospital, London, metastases were noted to be absent in 21 per cent (Raven, 1931). Of fifty-seven autopsied cases, Zuppinger (1936) reported 33.3 per cent without metastases (Röntgeninstitut, Kantonsspital, Zürich). Watson (1936) noted that in autopsies at the Memorial Hospital, New York,

*For studies of the well-developed lymphatic network in and about the walls of the esophagus, see Kuzuya (1923) and Miyazaki (1933).

there were secondary deposits in about 50 per cent of the cases. He remarked that "carcinoma of the esophagus very often remains to the end a localized disease and death results from perforation of the growth into a vital structure." No matter what the exact figure may be, it seems evident that, from the point of view of metastases, even very late in the disease at least 25 per cent of the tumors are removable. However, some of these, which would otherwise be favorable for excision, must be excluded as inoperable because the tumor has invaded important structures, such as the aorta or left main bronchus, or because of other serious organic disease. King (1936) saw twenty-five cases in a year's time; in two, or 8 per cent, the tumors were operable, although several more were explored. As in carcinoma of the stomach and colon, the rate of operability will probably increase with experience.

Emphasis has frequently been placed on the necessity of early diagnosis and the importance of putting the patient in the hands of the surgeon as soon as the lesion can be identified so that important time will not be lost (Rehn, 1898; Ach, 1913; Meyer, 1913, 1915; Jackson, 1925, 1935; Ricard and Ballivet, 1937). Most authors agree that in the majority of instances the tumors are resectable when the first symptoms appear. These symptoms, as described by Jackson (1925), are often indefinite, but should lead promptly to esophagoscopy examination. Farrell (1930) noted that, because of the possibility of underlying malignancy, the esophagus should be re-examined after the removal of impacted foreign bodies, especially in older people. Since cough may occasionally be the earliest symptom, the esophagus should be examined in all cases of unexplained cough (Jackson and Jackson, 1933). The dysphagia may be intermittent. Burning sensation under the sternum was a prominent symptom in patients of Moersch (1937) and Garlock (1938). The early symptoms, however, may not always lead to a diagnosis (Sherman, 1928; Mathews and Schnabel, 1935; McGibbon, 1936; Loeper, Riom, and Perreau, 1936), and cases have been recorded in which metastases (New and Vinson, 1924) or evidences of invasion (Keefer, 1934) gave the first indication of the disease. Nevertheless, the evidence at hand indicates that diagnosis by roentgenography and esophagoscopy can be made sufficiently early so that the surgeon should be able to remove about 10 per cent of these tumors. A point in the patient's favor was brought out by Master (1925). He found the red blood cell count normal, or slightly elevated due to concentration, in contrast to the count in patients with carcinoma of the stomach, who were, as a rule, anemic. Schaer (1930) and Sharp (1931) found leucoplakia of the esophagus to be very common, especially in males over 40 years of age. It may be precancerous in some instances, but it is impossible to foretell malignancy on the basis of leucoplakia as seen at esophagoscopy.

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proportion at 4 to 1; Macmillan (1935) reported 6 to 1. Watson notes that 3.5 per cent of all deaths from cancer in New York City are due to carcinoma of the esophagus. Clairmont (1924) estimated that about 25,000 men die of carcinoma of the esophagus in Europe annually.

Palliative Treatment.—In some of the clinics where endoscopic technique is highly developed, palliative treatment is carried on for the most part by repeated dilatation of the stenosed area on a string previously passed (Vinson, 1923, 1925, 1936; Moersch, 1929; Leven and Bowers, 1938), or by dilatation plus the insertion of an inlying coiled wire tube with an upper shoulder to keep it in place (Souttar, 1927, 1934; Murray, 1931; Howarth, 1932), with or without radiation. Most of these clinics do not favor gastrostomy, but Jackson (1935) recommends early gastrostomy, rest, and proper feeding. Others (e.g., Friedenwald, Zinn, and Feldman, 1927; Tasche, 1932; Watson, 1933) recommend gastrostomy, usually by a technique which provides a permanent valved opening from which the tube may be removed between feedings.

Carcinoma of the Upper Esophagus.—Two factors appear to have contributed to a recent lack of interest in carcinoma of the upper third of the esophagus, as compared to the enthusiasm shown in the attack on growths in the middle and lower thirds. In the first place, the cases are not so common; second, the field of operation is ill defined and the lesion most frequently encountered (Trotter's young and middle-aged female type of hypopharyngeal epithelioma) is prone to be neglected both by the laryngologist and the thoracic surgeon. Paterson (1931) warned that in this disease the original diagnosis is almost always hysterical dysphagia. In this review the hypopharyngeal epitheliomas will be considered with the upper esophageal tumors because they so often extend into the esophagus.

Billroth's (1871) demonstration in dogs that a portion of the cervical esophagus can be removed successfully laid the foundation for the original esophagectomy for carcinoma by his associate, Czerny (1877). By the time of Mikulicz's paper (1886), ten similar resections had been done. There followed, among others, the reports of Garrè (1898), Gluck (1898, 1913), Trotter (1913), Gluck and Soerensen (1920, 1923), Logan Turner (1920), Küttner (1921), Sauerbruch (1925), Torek (1926), Lotheissen (1929), Zaaijer (1930), Orton (1930), Zange (1931), Evans (1933), Ingebrigtsen (1933), Truesdale (1934), Lewis (1934), Pileher (1937), and Hoover (1938).

Out of the 200 or so epidermoid carcinomas of the hypopharynx, and the ten or twelve originating in the upper esophagus, which have been resected, no more than ten are reported to be cured for more than five years (Gluck, six cases, 1923; Wallace, 1920; Evans, 1933; Trotter, 1937; Hoover, 1938, 1939). The tumors in Trotter's and Hoover's cases were confined to the uppermost portion of the esophagus. All of the other growths which were cured involved the hypopharynx, although

Surgeons such as Sauerbruch, Meyer, Torek, Zaaier, Lilienthal, Eggers, and Turner have persisted in their attempts to combat carcinoma of the esophagus surgically because of the disappointing ineffectiveness of radium and x-ray treatment, at least as at present applied. Of the many thousands of patients so treated, only about twenty are reported to be cured and many of these cures are questionable either because insufficient time has elapsed or because the histologic evidence is incomplete. Guisez (1930, 1936) claims about fourteen cures by radium therapy, mostly in the "basal cell type of tumor in the midesophagus." Though he has had no permanent successes himself, Watson (1933, 1934) is much impressed by Guisez's results. Hill (1924) reported one patient well seven years after treatment by radium, another after three and one-half years. In seven additional cases of seventy-seven treated, the local tumor disappeared completely for from six months to five years. Dufourmentel (1930) recorded a six-year cure of a "basal cell epithelioma"; two other patients were alive and apparently well at the end of four and three years. Crump and Kasabach (1935) completely destroyed a squamous cell carcinoma of the upper third by radium and deep x-ray therapy, as shown at autopsy. In two cases treated by heavy external radiation at the Memorial Hospital, New York, the carcinoma was eradicated, but death had occurred from perforation and suppurative mediastinitis, the result of radiation (Watson, 1936). The many other writers on the subject report adverse or inconclusive results, but several express hope for the future based on new researches and improved techniques, particularly by external radiation (e.g., Pirie, 1923; Greene, 1924; Lewis, 1924; Mills and Kimbrough, 1925; Wright, 1929; Moran, 1930; Howarth, 1932; Teperson, 1932; Beck and Guttman, 1932; Cleminson and Monkhouse, 1934; Levitt, 1934; Zuppinger, 1936; Cain and Solomon, 1937). Woodman (1929) and Cleminson (1929) treated several patients by thoracotomy and direct implantation of radon seeds. Woodman's report in 1931 indicates that the method as applied was ineffective. Ricard and Ballivet (1937) expressed the belief that if surgeons had a chance to resect the large number of early cases now sent to radiologists the surgeons' results would be incomparably better than any the radiologists have been able to present.

That the subject of carcinoma of the esophagus is of great importance is indicated by the figures of Hoffmann (1934) and Watson (1936). Hoffmann, as consulting statistician for the Prudential Insurance Company, found that in the United States registration area the death rate from the disease had increased from 1 in 100,000 in 1915 to 1.7 in 1932. The rate for England and Wales was 5.9 in 100,000; Scotland, 4.9; Irish Free State, 5.2; Northern Ireland, 3.5. In England and Wales for 1931, the proportion of males to females was approximately 3 to 1. Most statistics, including those of Guisez (1935), in France, place this

Through a cervical exposure, Küttner (1921) freed a growth at the level of the clavicles and successfully invaginated the lower stump of the esophagus, leaving a pack in the upper mediastinum. Sauerbruch (1925), Zaaier (1930), and Evans (1933) found that the esophagus may be severed in the upper mediastinum as low down as the arch of the aorta and that, by inserting a tube and packing around it, serious mediastinitis did not occur. Zaaier's exposure included the removal of the manubrium and portions of the clavicle and first and second ribs. Sauerbruch (1925) described a right anterior upper thoracic approach for growths immediately below the thoracic inlet, and Butler (1937) noted that a good exposure of the region is obtained at the time of a Semb (1935) posterior thoracoplasty.

The results of surgical excision in the upper esophagus have not been encouraging on the whole, but they are good enough to stimulate the conscientious surgeon to make continued attempts at cure. Radiation appears to be ineffective except for palliation.

Carcinoma of the Midesophagus.—About one-half of the carcinomas of the esophagus involve the middle third. As a rule, the entire thoracic portion must be removed if a cure is to be hoped for (Torek, 1927). Excisions of this nature have been carried out with increasing frequency during the past few years and there is cause for some encouragement in a heretofore disheartening field.

When discussing carcinoma, a careful distinction must be made between operative success and cure. The only certain cure of a carcinoma of the midesophagus was obtained by Torek (1913), whose patient lived twelve years after the resection and died at the age of 80 years of pneumonia without recurrence, as shown at her autopsy (Torek, 1927).*

Even the operative successes were few and far between up to the present decade. Among an estimated 100 attempts between 1913 and 1930, successful excisions of the midesophagus were recorded only by Zaaier (1913, 1929), Torek (1913), Lilienthal (1921), and Eggers (1925). During this time, the technique of thoracic surgery had become quite highly developed and it seemed almost impossible that the results should be so poor.

One point in technique gradually became firmly established: that following a transpleural operation for carcinoma of the esophagus a catheter should be led, airtight, out of the pleural cavity to a container of sterile water placed on the floor. Torek did not use drainage of any kind in his successful case, but Willy Meyer (1915) considered the result distinctly fortunate, and the successful cases of Eggers (1925, 1930), who drained, and the many failures of others (e.g., Bessesen and Bessesen, 1931) who did not drain, indicated that a tube probably should be inserted. The end of the catheter should be placed no more

*Some of the early experiments on which Torek's technique was founded are described in the work of Kelling (1904).

some of them may have originated in the upper esophagus. In Evans' patient, a female, aged 63 years, a squamous cell carcinoma which involved the larynx and esophagus extensively had been removed twenty-three years previously. She now lived in comfort by the use of a rubber esophagus which she inserted between the cervical opening and the gastrostomy at each meal. Trotter's patient, a male, was well at the age of 72 years, ten years after excision of an epidermoid carcinoma. In Hoover's case, a woman, aged 49 years, had had dysphagia for five months; biopsy showed a small, Grade 1, epidermoid carcinoma at the upper end of the esophagus. Bilateral dissection of the cervical lymph nodes showed no metastases. Ten days after removal of the nodes, the localized upper esophageal tumor was excised through a right lateral wound by removing a portion of the thyroid ala (Trotter's hypopharyngeal approach). It was possible to retain a narrow strip of the wall of the lower pharynx and esophagus. A Levine tube was inserted and later a thread was passed and dilatations were carried out over it. At present there is no evidence of recurrence and a 7 mm. esophagoscope can be passed without difficulty.

In at least two of the cured patients recurrent laryngeal paralysis had occurred previous to the resections (Evans, Trotter). In most of the cases the regional lymph nodes have been excised, but usually they have not been found involved. In Gluck's six cases, and in Evans' case the larynx was removed, but Trotter and Hoover did not find this necessary.

The techniques of lateral pharyngotomy, local resection of the upper esophagus, and radical laryngopharyngo-esophagectomy, together with the plastic procedures requisite for preservation and restitution of the respiratory and swallowing functions, are well described in the references cited (see also Pokotilo, 1930).^{*} Wilensky (1914) emphasized the importance of a preliminary gastrostomy. Trotter (1913) stressed the desirability of determining the exact site and, whenever possible, the approximate extent of the growth before operation in order that the plans for excision and reconstruction by fascial and skin flaps should be more perfect. Churchill (1935), using the methods of reconstruction described by Trotter, found that the two patients from whom he excised hypopharyngeal carcinomas were never able to swallow anything except small amounts of liquids. King (1936) noted that, because of the possibility of invasion of the primary bronchi or trachea by the growth, "bronchoscopy should always be performed when the growth is at or above the level of the sixth thoracic vertebra." Rutherford's experience (1934) emphasizes this point; during an operation by the cervical route he found the trachea infiltrated by tumor.

^{*}A curious sequel of a plastic operation of this nature was recorded by Roberts (1934) in a man whose esophagus became obstructed by hair which grew down from a flap of skin which had been turned in from the neck to close a pharyngeal fistula following a laryngectomy for carcinoma.

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than one inch within the pleural cavity (Abel, 1926). Occasionally the tube becomes walled off between the lower lobe of the lung and the diaphragm and fails to keep the pleural cavity empty, as demonstrated in my personal experience. For this reason it may be wise to leave a second catheter at a higher level. In some cases it might seem best to the operator to pass a third airtight tube into the lower mediastinum, and possibly a fourth through the skin and sternomastoid muscle into the mediastinum from above. The incidence of empyema following any transthoracic operation on the opened esophagus remains extremely high. By this use of closed drainage with a water seal, introduced in 1911 by Kenyon for empyema, the dangers of empyema and mediastinitis are diminished.*

No other essential changes in technique have been introduced since Torek's first operation. As a matter of fact, the principles which should have led to success were known to Sauerbruch as early as 1909. But, time after time, during the seventeen years between 1913 and 1930, some error in technique, or an unforeseen but often preventable circumstance in the preoperative or postoperative care, brought disaster to the patient (Unger, 1913; King, 1936); and the errors still continue, so difficult is it to carry through the entire program with good judgment. The many tragedies led Lilienthal (1921, 1923) to persist with the posterior mediastinal approach (operation of L. Rehn, 1898). This minimized the dangers of infection, but it is not favored by most operators because of inadequate exposure and the inability to remove a segment of esophagus long enough to insure against recurrence.

The errors in technique which led to fatalities in so many cases by the transpleural route were mostly those which resulted in mediastinitis, empyema, atelectasis, and pneumonia. Less often the patients died quickly as the result of trauma and hemorrhage. Some reports have incriminated the cardiac musculature or vagal inhibition, but, if the patient is kept well oxygenated during anesthesia and the tissues are handled gently, there is little reason to believe that these are important factors.

Mediastinitis, in not a few instances, has occurred as the result of rupture of the tumor during attempts to free it (e.g., Bunnell, 1922). Most writers who have had this experience have noted that the tumors were obviously so fixed to surrounding structures as to be inoperable and that efforts to remove the growths should not have been persisted in. In another group of cases ligatures have slipped off the esophagus, resulting in gross contamination of the mediastinum. This tragedy can be prevented by tying tightly, and doubly, with heavy braided silk or tape. Kelling (1904) appears to have been the first to use a finger

*Edwards (1936) carried out a very satisfactory operation in a male, aged 60 years, but no drainage was provided. Fluid collected, and on the tenth day was purulent. The patient died on the twenty-first day of empyema and pneumonitis. Edwards ascribed this unfortunate result to failure to drain.

cot over the esophageal stump to help prevent mediastinal infection during exteriorization. This technique has been utilized by Lotheissen (1924), King (1936), Edwards (1936), and Garlock (1938). King and Garlock left the mediastinal pleura open intentionally, seeking in this way to afford drainage for the mediastinum through the catheter left in the pleural cavity.

From the time of the earliest operations, surgeons have had difficulty in dealing effectively with the upper stump of the esophagus. When it is brought directly out of the cervical wound, it acts as a path along which organisms enter the serum-filled mediastinum, thus inciting mediastinitis on the second or third postoperative day. When it is passed, as it should be (Ach, 1913; Rehn, 1913; Torek, 1913, 1929; Turner, 1932), through a tunnel of normal subcutaneous fat before it emerges through an opening in the skin, a portion of its distal end may become necrotic from insufficient blood supply, thus leading to subcutaneous gangrene and retrograde mediastinitis. The blood supply of the esophagus should never be severed so high as to require the ligaturing of the inferior thyroid artery (Gohrbandt, 1927). The stump should be handled carefully to avoid injury to the muscular coats. It should not be acutely angulated over the manubrium and should be brought under the skin and subcutaneous tissues only for 4 to 6 cm. It should be stitched to the skin with fine interrupted silk sutures which exclude it completely from the mediastinum without interrupting the supply of blood to the exteriorized portion. Extreme care should be taken to avoid puncturing the mucosa. A large catheter should be sutured into the stump and connected with a suction apparatus. If it is necessary, because of a short stump or faulty nutrition, to bring the esophagus directly out through the cervical wound, the patient should be nursed in Trendelenburg's position, and the gauze packing about it should be changed very frequently to keep it dry (Turner, 1932). In Fischer's successful case (1937) the esophagus was led out of the cervical wound for a distance of 10 cm. and a tube was tied into it. Remoteness of the source of contamination prevented infection, but possibly it would have been safer to bring the esophagus out under a bridge of skin.

Empyema, atelectasis, and pneumonia most often have been the result of failure of complete expansion of the lung at the time of closure of the chest. Aspiration of the residual air immediately after operation probably should be done more often. Patients have died also because air leaked inward through the thoracic wound, through the site of drainage, or through the cervical wound. The cervical wound should be closed airtight. If cervical drainage of the mediastinum is thought to be desirable, a catheter might be placed through the skin and sternomastoid muscle, airtight, and brought out under a water seal.

The tendency toward atelectasis and pneumonia appears to be increased when the phrenic nerve is paralyzed. Some authors have

ascribed pneumonitis to intratracheal anesthesia, but the evidence is not convincing. Rather, it occurs as a rule in association with widespread sepsis and atelectasis due to the presence of fluid and air in the corresponding pleural cavity, with or without paralysis of the diaphragm. Retention of secretions in the bronchial tree due to inability to cough them up may be the cause. Under these conditions, aspirations of the bronchial tree may be lifesaving (Haight, 1938). I have found that the introduction of a tracheotomy tube under local anesthesia is of great value in cases where suction must be repeated at frequent intervals.

Turner (1933) and Fischer (1937) prevented pulmonary and pleural complications by blindly, but carefully, tunneling out the esophagus by the abdominocervical route (operation of Denk, 1913). Turner's and Fischer's patients recovered; Orton (1936), who used the same technique, lost his patient on the sixteenth postoperative day only because the abdominal wound ruptured. Gohrbandt (1927) expressed the opinion that this operation is less severe for the patient than the transpleural operation. However this may be, Turner (1934), who has had the greatest experience with this "pull-through" method, discusses with some misgivings his difficulties, such as tearing of the growth, tearing of the pleura, postoperative hemorrhage and effusion into one or both pleural cavities. For growths of the middle portion of the esophagus he is "inclined to give further consideration to the posterior mediastinal or the transthoracic route."

Seiffert (1929, 1935) demonstrated the feasibility, at least in his own hands, of the endoscopic excision of some of the tumors. In view of the fact that he had successfully treated a patient with a fresh perforation of the esophagus by splitting almost the entire length of the organ endoscopically, it occurred to him that a circumscribed section of the esophagus might be removed from within, leaving the raw bed to retract and heal. One of his three patients is reported well over five years after such a resection and none of them died of mediastinitis. Moersch (1937) reported a successful excision by the endotherm through an esophagoscope.

From the standpoints of exposure and likelihood of complete removal, the soundest approach to tumors of the midesophagus appears to be the transthoracic. Since 1930, successful operations of this nature have been carried out by Eggers (1930), King (1936), Edwards (1936), Radford (1937), Brunn and Stephens (1937), King (1937), Garlock (three cases, 1938), Garlock (1939), Adams (1939), and Churchill (1939). Carter (1939) lost a patient, eight weeks after an apparently successful Torek operation, from basal meningitis secondary to multiple small abscesses of the left lung.

King (1936) makes the statement that "a negative microscopic finding must not be regarded as more important than the combined evidence obtained by the other observations." This point of view may be justified

in some instances, but Eggers (1938) and Whipple (1939) removed the esophagus in cases of supposed carcinoma, only to find that the specimens contained no new growth (see the section on Foreign Bodies, Infections and Their Complications, page 789). In both instances the patients recovered. If repeated biopsies taken from above have been negative, a specimen removed by retrograde esophagoscopy through a gastrostomy may identify the lesion (Lotheissen, 1924). Tissue may be removed from the lower end of a growth through an esophagoscope, passed by way of the stomach at the time of laparotomy (personal experience of the reviewer). Most authors insist on definite diagnosis (e.g., Jackson, 1935).

Torek (1927) objected to a right-sided transpleural approach for tumors which extend below the aortic arch on the grounds that the liver, diaphragm, and pericardium may prevent the removal of an adequate segment of normal esophagus below the tumor. He pointed out that a larger proportion of lung is collapsed during a right-sided than during a left-sided operation. Lotheissen (1924), Abel (1926), O'Shaughnessy and Raven (1934), Ricard and Ballivet (1938), and Churchill (1939) are impressed with the possibilities of the right-sided route in selected cases.

The operation of Torek may be converted into a two-stage procedure by severing the esophagus in the upper mediastinum by a cervical approach, closing the lower stump and bringing the upper stump out at the neck at the time the gastrostomy is performed or as a separate preliminary step (Lotheissen, 1924; Ohsawa, 1933; Eggers, 1938). In case the tumor later is found to be inoperable, no harm has been done and the patient in fact may be benefited if the esophagostomy and gastrostomy are connected by a rubber tube so that food can be taken by mouth in a more or less normal manner (Levy, 1898; Zaaijer, 1930; and others). Torek, in discussing Eggers' paper, pointed out that by this technique only a short segment of upper esophagus can be brought out. This might result in suppurative complications in a larger number of cases than would occur if a longer segment were tunnelled under the skin, as in the original technique. Carr (1939) is convinced that the esophagus cannot be divided low enough in the mediastinum to achieve the purpose safely. However, the method merits the fullest consideration and it should be recalled that a considerable number of successful cervical esophagostomies, with complete division of the tube and closure of the lower segment, have been carried out as a step in antethoracic esophagoplasty. Inasmuch as the pleura is not opened, it might be advisable to pack the upper mediastinum and bring the upper esophagus out of a more or less open cervical wound or under a bridge of skin, leaving the cervical wound packed open. Essentially the same technique was used several years ago in the resection and palliation of carcinomas of the cervical and upper thoracic esophagus (e.g., Küttner, 1921).

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Following a preliminary abdominal exploration and jejunostomy, Churchill (1939) removed a carcinoma situated immediately below the arch of the aorta through a right-sided thoracotomy wound. The upper stump of esophagus was sutured into a small, left, lower cervical incision made under guidance from within the thorax. Several weeks later, by laparotomy, the lower stump of the esophagus was freed from the mediastinum and brought out to the skin at the left of the xiphoid process. The skin about the opening has remained reactionless. Churchill believes the squamous epithelium of the esophagus is much more likely to unite kindly with the skin than the mucous membrane of the stomach or jejunum. Completion of the antethoracic esophagus is contemplated.

When the left-sided approach is used, Garlock's (1939) present technique appears to be an improvement over Torek's in that the entire thoracic procedure can be completed before the neck is opened. This lessens the likelihood of infection both in the thorax and in the cervical region. The tumor is removed and the proximal esophageal stump (which is ligatured, carbolyzed, and protected by a rubber sheath) is placed in the posterior superior mediastinum. The pleura above the aortic arch is sutured over it and the thorax is closed. Then the cervical approach is made with a clean operative setup, and the stump is exteriorized.

Carcinoma of the Lower Esophagus.—Tumors which originate in the cardia of the stomach and ascend to involve the lower esophagus present essentially the same surgical problem as growths which begin in the lower esophagus itself. Operations on both types of lesion will be considered together here. The carcinomas which arise in the esophageal mucosa are less likely to metastasize early to the regional abdominal lymph nodes and to the liver (Helsley, 1923) and should be more often curable by resection. However, no accurate information is available on this point because most of the resections have been carried out so recently that the final results are unknown.

Previous to 1938, the only successful operations on carcinomas in this region were recorded by Voelcker (1908), Kümmell (1910), Bircher (1918), Hedblom (1922), Gohrbandt (1927), Miyagi (1927), Ohsawa (eight cases, 1933), Ingebrigtsen (two cases, 1933, 1936), and Muir (1936). Torek (1927) states that Voelcker's and Bircher's patients were cured permanently. The resections of Voelcker, Kümmell, Bircher, Gohrbandt, Miyagi, and Ingebrigtsen were accomplished through abdominal incisions without opening the pleura. Those of Hedblom and Muir were combined abdominal and thoracic resections in which the severed proximal esophageal stump was brought out through the thoracic wound, later connected with a gastrostomy tube so that feedings were taken by mouth. Hedblom performed a three-stage preliminary thoracoplasty similar to that of Zaaizer (1913) for a tumor of the midesophagus.

In spite of the fact that Biondi (1895), Sauerbruch in his early work, and Janeway and Green (1910) had worked out an apparently satisfactory endothoracic esophageal-gastric anastomosis on dogs and cadavers, no successes in human cases were recorded until Ohsawa's in 1933. Bengolea nearly succeeded in 1919, but his patient died of empyema on the thirty-seventh postoperative day. It is worthy of note that Bengolea was one of the first, perhaps the first, to employ Kenyon's (1911) closed catheter drainage following a transpleural esophageal resection. Unfortunately, it appears that he removed the tube prematurely and re-drained too late. Miller and Andrus (1923) resected the lower esophagus successfully in dogs in eleven out of eighteen attempts. They brought the fundus of the stomach into the thorax through a left transpleural incision and anastomosed the esophagus to the stomach, end-to-side. Among the animals that died, dilatation of the stomach occurred twice, diaphragmatic hernia once, and pleural infection three times. Heuer, Andrus, and Bell (1925), elaborating a method suggested by Mikulicz (1904), transplanted the left leaf of the diaphragm to a high level about the esophagus, allowing the resection of the lower portion and an anastomosis to the stomach to be carried out below the diaphragm. The method has not been applied successfully in man. Fischer (1926) suggested paralyzing the diaphragm and implanting the stump of the esophagus into the wall of the stomach by a flap method. He did not have an opportunity to perform this operation himself, but Starr independently made use of an almost identical technique in 1922. Starr's patient died of a pulmonary embolus on the fifth postoperative day, but the anastomosis was thus far sound. Decker (1935) performed the operation as suggested by Fischer, but lost the patient in twenty-eight hours due to edema of the right lung and atelectasis of the left; the lung had not been completely expanded at the time of closure and no transfusion was given.

Ohsawa (1933) failed in five attempts to remove carcinomas in the midesophagus, but his results for tumors in the lower esophagus, cardia, and upper stomach are remarkable. During the seven years preceding 1933, 803 cases of carcinoma of the stomach, without involvement of the cardiac portion, were operated upon (clinic of Prof. R. Torikata and Prof. K. Isobe, Kyoto Imperial University); during the same time, 101 carcinomas of the esophagus, cardia, and upper stomach (involving the cardia) were explored. Forty-three resections were carried out in the group of 101; 5 for tumors of the midesophagus, with no recoveries; 18 for tumors of the lower esophagus and cardia, with 8 recoveries; and 20 for tumors of the stomach which involved the cardia, with 12 recoveries. The latter 20 operations were total gastrectomies and in some of them as much as 5 cm. of the esophagus were also removed. These operations were carried out by what Ohsawa designates as his semi-thoracotomic transabdominal technique or by the free thoracolaparotomic

technique. The group of 18 excisions were completed by esophago-gastrostomy by the semithoracotomic transabdominal technique.*

At the spring meeting of the American Association for Thoracic Surgery, Atlanta, 1938, Adams and Phemister reported the first successful thoracic esophagogastronomy for carcinoma performed outside of Japan. This was for squamous-cell carcinoma of the lower third of the esophagus. The resection followed careful preparation by experimental work on dogs and the authors had profited by experiences derived from a previous unsuccessful case. Ogilvie (1938), attempting a similar

*Inasmuch as Ohsawa's publication is not generally available, a rather detailed description of his approaches is outlined below. It should be emphasized that all of Ohsawa's thoracic operations are done without differential pressure. He says this is easier and safer. Oxygen is always inhaled by the patient, but increased pressure is avoided; he believes positive pressure is detrimental both at operation and post-operatively, presumably because of retention of carbon dioxide. Many of the operations are carried out with procaine anesthesia. In brief, he claims that in the human being the loss of respiratory function on one side is sufficiently compensated for by overventilation, with added oxygen, on the other, and that return to a normal respiratory and circulatory status, throughout the body, is prompt after free thoracotomy than after thoracotomy under differential pressure. It should be recalled that many of the World War surgeons dispensed with positive pressure in their operations for thoracic injuries. Ricard and Ballivet (1938) did not use it in their unsuccessful Torek operation.

Semithoracotomic Transabdominal Technique.—This is practically an abdominal substitute for free thoracotomy, and exposure makes use of Marwedel's (1903) left costal release and of Lambert's (1912) mobilization and retraction of the left lobe of the liver. In addition, the hiatus is freed and the diaphragm may be split. The U-shaped skin incision raises a musculocutaneous flap which bares the left upper abdominal muscles and left lower ribs anteriorly. About 3 cm. of the seventh, eighth, and ninth ribs or their cartilages are resected, 8 to 10 cm. from the midline; the ninth intercostal space is incised for a length of 5 cm. and the costosternal attachment of the seventh rib is divided; thus, the left costal arch is destroyed and is retracted upward. If the pleura is injured during this maneuver, no attention is paid to it. The triangular ligament is incised and the left lobe of the liver is retracted toward the right. The peritoneum covering the esophageal hiatus is cut through circularly, the esophagus exposed, and the conditions of this segment of the gullet are inspected. "By this method, we have been able to expose about 10 centimeters of the lower part of the esophagus in most of our cases. . . . Depending upon the conditions of the tumor and the presence of adhesions, however, this form of operation may be insufficient and it may become necessary to open the thorax. . . . We believe that in those cases of diseases of the lower portion of the oesophagus and cardia which require thoracotomy, free transdiaphragmatic thoracotomy is the method of choice. For somewhat more complicated cases, free thoracotomy or laparothoracotomy is the most acceptable technic in our opinion."

O'Shaughnessy and Raven (1934) comment on Ohsawa's semithoracotomic transabdominal technique as follows: "On the cadaver, we have found that his method of opening the chest from the abdomen when following the oesophagus up towards the lung root is open to some objections: an incision in the diaphragm stretching from the esophageal hiatus to the costal border is liable to wound the pericardium, and the closure of this incision offers great technical difficulty. At the same time this method does permit of a preliminary exploration from the abdomen, and although we personally should prefer to begin with the left transpleural approach and then, if access to the cardiac end of the stomach was desired, divide the diaphragm from above (with the pericardium intact), the results obtained by Ohsawa are so remarkable that it seems impossible to dismiss his suggestion lightly." This criticism is not entirely justified because Ohsawa makes it clear that he also prefers the thoracotomy technique for the tumors which extend much above the hiatus.

Free Thoracotomy Technique.—Ohsawa continues: "In case the laparotomy is to be done first, either a midline or left pararectal incision is made from the seventh costal cartilage to somewhat above the navel; the peritoneal cavity is opened and the conditions of the viscera examined; and then the skin incision is extended upward and laterally along the chest wall so that it forms an arc with the left eighth rib as its chord, the posterior superior limit of the incision corresponding to the height of the inferior angle of the left scapula. Then segments approximately 1.5 centimeters long of the seventh and eighth ribs are resected. (At times only the eighth rib is resected, and occasionally no rib resection is necessary.) The pleura is incised in the seventh intercostal space, and the intrathoracic conditions are reviewed. Next the costal arch in the seventh intercostal space is cut through. The diaphragm is now divided from this point to the esophageal hiatus, thus converting the abdominal and thoracic cavities into a single field of operation. After the necessary operative maneuvers are performed, the thorax is closed, using silk thread for suturing the divided costal arch. In case the thorax is opened first, the steps in the operation are merely reversed."

At the close of his operations, Ohsawa aspirates the air from the pleural cavity. He does not use closed catheter drainage, apparently, but aspirates and drains later as indicated. He notes that residual pneumothorax after thoracotomy favors infection.

procedure, lost a patient from atelectasis and pneumonia of the left lobes six days after resection of a carcinoma of the gastric fundus which had extended into the lower esophagus. Marshall (1938) successfully resected a similar tumor. By correspondence, I have learned of four other successful cases (Marshall, 1939; Ochsner and DeBakey, 1939; Carter, 1939; Cattell, 1939).

Cattell's operation was done in two stages. At the first, by the abdominal route under nupercaine spinal anesthesia, all of the blood supply of the stomach was divided except the right gastric and gastroepiploic arteries. The lower end of the esophagus was freed and the entire upper portion of the stomach and the lesion at the level of the diaphragm were displaced into the mediastinum. Fifteen days later, by a transpleural approach, the lower 4 or 5 inches of the esophagus were resected together with the upper portion of the stomach. A de Petz clamp was placed across the stomach, saving a large portion of the greater curvature which was brought up as a 5-inch tubular structure to join the esophagus. In order to avoid contamination, a braided silk ligature was placed around the esophagus and the stump was drawn into the stomach by traction through a counter incision lower down. It was later necessary to drain an encapsulated empyema. The pathologic examination showed adenocarcinoma without involvement of the lymphatic nodes. The patient required a few dilatations of the anastomosis but was in good condition five months after operation.

Ohsawa (1933) objected to implantation of the esophagus into the stomach by the Kader technique because "postoperative stenosis is unavoidable." Nevertheless, he admits that the method is superior in regard to healing. Because of the relative safety of the method, which can be made aseptic, it probably is to be preferred over methods of direct suturing, such as that of Adams and Phemister (1938). No matter what method of anastomosis is used, the gastric stump should be closed and the union should be made through a fresh opening made in the anterior wall of the fundus or greater curvature tube. Ohsawa makes use of pedicled omentum to surround the anastomosis.

Although the later results are not known, transthoracic resection and esophagogastrostomy seems within a short time finally to have become established as a satisfactory operation for carcinoma in the region of the cardia and in the lower 10 cm. of the esophagus. For small growths limited to the region of the cardia, the abdominal approach as used by the earlier operators is suitable, but for more extensive resection the thoracic route appears to have demonstrated its superiority.

As a preliminary to resections for carcinoma in the upper and middle thirds of the esophagus, gastrostomy or jejunostomy should always be done; but, if the patient's general nutrition is satisfactory, some surgeons have omitted this step when a direct esophagogastrostomy is contemplated (e.g., Ohsawa, 1933; Marshall, 1938). If extra feedings

are desirable, jejunostomy is preferable because it interferes less with the mobility of the stomach when the organ is displaced into the thorax at the time of resection (Fischer, 1926). However, some surgeons, recalling difficulties in feeding by jejunostomy, will prefer a gastrostomy in the pyloric antrum whenever the stomach is of a fairly good size.

As pointed out for many years, the upper abdominal lymphatic nodes and the liver should be examined for metastases at the time the gastrostomy or jejunostomy is made (Küttner, 1908; Meyer, 1915; Unger, 1913, 1915; Eggers, 1925; Turner, 1934; Lotheissen, 1924; Edwards, 1936).

Cattell (1939) and Marshall (1939) both emphasize that it is very important to crush the left phrenic nerve. In Marshall's one unsuccessful case in three the nerve was procainized. The patient died rather suddenly on the seventh postoperative day; apparently the reactivated diaphragm pulled the stomach away from the esophagus. Ogilvie (1938) considered that the atelectasis and pneumonia which caused the death of his patient were brought about by inactivity of the diaphragm. However, a quiet diaphragm is desirable during the time of healing of the anastomosis, and complete expansion of the lung at the time of closure, together with catheter drainage under negative pressure postoperatively, should usually prevent collapse of the lobes. A paralyzed diaphragm may also be desirable subsequently in order to prevent constriction of the stomach and consequent gaseous distention of the intrathoracic portion. Following esophagogastrostomy (i.e., after bilateral division of the vagus nerves), x-ray studies by Ohsawa (1933) showed, in six of eight cases, dilatation of the pyloric portion of the stomach with delayed passage, but the gastric peristalsis was not much affected (see also Lotheissen, 1924).

Resection of the left eighth rib usually gives ample exposure for removal of the lower esophagus and a portion of the stomach. The left phrenic nerve is crushed. The diaphragm is split radially from the thoracic wall to the esophagus, thus bringing to view the upper abdominal organs. The tumor and a suitable portion of normal esophagus and stomach are freed of their attachments and the mass including lymph nodes is removed by a technique similar to that already described in Cattell's case. The muscular esophageal wall can readily be sewed to the seromuscular covering of the stomach by a series of infolding interrupted Lembert and mattress sutures, as in a Stamm or Kader gastrostomy. The tie on the end of the esophagus is retained to slough off, and the counter-opening in the stomach is closed. The flaccid diaphragm is sutured to the stomach all around, and catheter drainage of the pleural cavity is provided. The thorax is closed tightly with lungs expanded or the residual air is aspirated immediately.

The blood supply of the stomach is so good that no fear of inadequate nutrition to the site of anastomosis should be felt (Adams, Esendero,

Aronsohn, and Shaw, 1938), provided the right gastric and right gastroepiploic arteries are intact. It is necessary and desirable to sever the coronary artery. The esophagus, on the other hand, has a rather poor collateral blood supply through its walls (Saint, 1929; Ohsawa, 1933) and it should be freed as little as possible above the site of ligature (only from 3 to 4 cm.).

Precautions in Esophagectomy.—The importance of careful preparation is emphasized by all surgeons who have had experience with esophagectomy (e.g., Abel, 1926; Eggers, 1931; King, 1936, 1937; Garlock, 1938). This preparation includes scaling or extracting teeth, administration of a high caloric diet with vitamins by gastrostomy or jejunostomy and by mouth if tolerated, daily lavage of the esophagus if there is retention or ulceration, and one or more blood transfusions. Preliminary pneumothorax is not essential, but was given by Sellors (1932), Edwards (1936), King (1936, 1937), Radford (1937), Brunn and Stephens (1937), and Ricard and Ballivet (1938). Ohsawa (1933) injects "koktigen" (a colon bacillus, or a combined streptococcus and staphylococcus vaccine) intrapleurally as a preoperative stimulant to phagocytosis. Sellors (1932) begins cleaning the skin several days before operation. King (1936, 1937) aims to diminish the severity of the esophagectomy by removing small segments of the fourth to seventh ribs and dividing the intercostal bundles several days before the main operation. Eggers (1931) illustrates in a drawing the correct position of the patient on the table. Mechanical supports against the manubrium, symphysis pubis, and sacrum are a help.

Almost all writers who use positive pressure anesthesia agree that expert administration is essential (e.g., Meyer, 1929). Brunn and Stephens (1937) believe that intratracheal anesthesia is superior to the use of an ordinary gas mask. Eggers (1925) and Garlock (1938) emphasize the importance of intermittent inflation of the lungs during operation. This improves the condition of the patient and helps prevent postoperative pneumonia. Radford (1937), using King's technique, kept the exposed pleural surfaces packed with a 1:1,000 flavine solution. Lotheissen (1924) recommended washing out the mediastinum and cervical wound with an antiseptic, such as boroform or chloramin, followed by novoiiodine.

Atropine should be given routinely in order to guard against overstimulation in vagotonic patients. The greatest care should be taken to avoid tugging on the vagi, but, when necessary, they may be cut cleanly at any level below the exit of the cardiac branches. Most of the recent operations for carcinoma of the thoracic esophagus have been carried out without procainizing the vagi; however, this may be done with advantage in patients who show respiratory or cardiac effects when the esophagus is being freed. (For discussions of this interesting subject

see Heller, 1913; Eppinger and Hess, 1917; Lotheissen, 1924; Torek, 1927, 1929; Zeller and Burget, 1937).

Ohsawa (1933) noted that pressure against the pericardium over the auricles is far more detrimental than corresponding pressure on the ventricles. Handling of the aorta should be avoided so far as is possible.

No injuries to the thoracic duct during esophagectomy thus far have been recorded. Because of numerous anastomoses with other lymphatic ducts and with veins (Lee, 1922; Blalock, Robinson, Cunningham, and Gray, 1937), ligation of the main channel, though obviously undesirable, usually does not lead to serious consequences. Division of the main duct without ligaturing it no doubt would be disastrous.

One or more transfusions and 40 to 50 per cent oxygen by nasal tube should always be given postoperatively. A tent interferes with other necessary care. Sulfanilamide might be given prophylactically, but it may interfere with healing (Bricker and Graham, 1939). King (1936) noted that his patient gained weight after saliva was added to his food, but Wilder and Stokes (1931, 1932), on the basis of experimental and clinical observations, concluded that proper dietary management is more important than the presence or absence of saliva.

Follow-Up.—Late reports on patients who have survived esophagectomies are very incomplete, but Eggers (1933) noted recurrence in both of his patients. Turner (1934) reported the death of his patient, nineteen months after an abdominocervical resection, from chronic nephritis and cardiovascular complications; there was no evident recurrence. Of Garlock's first three patients, one died twenty-two months after operation with a mass in the superior mediastinum; the second is alive and well going on three years; the third died of coronary thrombosis four and one-half months after resection. A complete autopsy failed to disclose any remaining carcinoma (1939).

OTHER MALIGNANT TUMORS OF THE ESOPHAGUS

Jackson (1925) reported that among 671 cases of malignancy of the esophagus, 337 were squamous cell and atypical epitheliomas, and 316 adenocarcinomas, the latter mostly at or near the cardia. Sarcomas were found in only four cases.

Dvorak (1931) noted that less than fifty cases of sarcoma of the esophagus had been recorded. Metastases are most likely to occur in the diffuse infiltrating type of round-cell sarcoma, but are predominantly absent in the circumscribed polypoid spindle cell-sarcoma. Dvorak's patient died of suffocation; a rhabdomyosarcoma, 4 to 5 cm. in diameter was found about 5 cm. below the pharynx. The trachea was not involved and there were no metastases. "The lesion appeared operable."

Scarff (1929) found that only seven instances of carcinosarcoma of the esophagus had been recorded previously. He added one in a patient

who died of perforation of the aorta, four months after intensive radium therapy. The erosion may have been due either to radium necrosis or decubitus from the lower end of a Souttar's tube. In two cases the tumors were pedunculated, and in five, including Scarff's, there were no metastases.

Primary leiomyosarcomas of the esophagus were recorded in a Cabot case (1935) and by Menne and Birge (1937). In the Cabot case regurgitation of mucus had been present for ten years, suggesting that the tumor had grown as a benign lesion before becoming malignant.

Jaleski (1935) performed autopsy on a case of primary melanotic sarcoma of the esophagus, examples of which he had found recorded only three times before. In none of the cases did the tumor obstruct the gullet.

None of the few resections (all cervical) which have been performed for esophageal sarcomas have been curative (von Hacker and Lotheissen, 1926). Radiation is equally ineffective.

A post-mortem specimen showing lymphosarcoma of the lungs and mediastinal lymph nodes which invaded the esophageal wall and perforated it, producing a fistula, is illustrated by Graham, Singer, and Ballon (1935).

FOREIGN BODIES, INFECTIONS AND THEIR COMPLICATIONS

Perforations From Within by Foreign Bodies and Instruments.—Foreign bodies in the esophagus are of surgical interest chiefly because of the complications which may arise if they are not soon removed. A few bizarre cases may be mentioned. Guthrie (1920) related the story of an infant, aged 9 months, in whom at autopsy the head of a large bone collar stud was found to have ulcerated through the posterior wall of the esophagus so that it projected into an abscess, the size of a walnut, which occupied the body of the third dorsal vertebra. Only a thin lamina of bone separated the abscess cavity from the spinal canal and at this point there was localized inflammation of the meninges. Van Gilse (1924) noted the remarkable course of a child, aged 2 years, in whom the back plate of a garter button eroded from the esophagus into the trachea, resulting in a valvelike perforation through which air passed forcibly, inflating the entire intestinal tract. The child expelled much flatus but belched not at all. On removal of the foreign body, the fistula closed rapidly, with recovery. A male, aged 43 years, who had swallowed a piece of duck bone five days before, died of profuse hēmatemesis. The bone was found spanning the lower esophagus just above the cardia; one of the sharp ends had eroded an artery in the esophageal wall (Saltzstein, 1932). McClure (1934) recorded the case of a boy, aged 20 years, in whom, after swallowing a sliver of chicken bone, x-rays and esophagoscopy were negative and all symptoms disappeared. However, the patient died of perforation of the aorta one month later.

Neglected foreign bodies most often perforate into the cellular tissues of the neck or mediastinum, with ensuing cellulitis or abscess. Sudden and extensive outflow of esophageal contents is usually the result of ill-advised, often blind, instrumentation, during which a sharp portion of the foreign body or the instrument itself plunges through the wall of the esophagus. The same thing may happen during the dilatation of a benign (e.g., Imperatori, 1933) or malignant stricture, or rarely during the investigation of a diverticulum.

The prevention of perforations by foreign bodies and instruments has been emphasized repeatedly for many years (e.g., Jackson, in his numerous publications; Schlemmer, 1919; Imperatori, 1933). The campaign has been successful to a degree, but there remain quite a large number of cases of potential or actual perforation which tax the clinical judgment and skill of the endoscopist and surgeon.* Most foreign bodies, even large dentures (after fragmentation), can be removed safely by an expert esophagoscopist if the attempt is made within one to three days after ingestion (Schlemmer, 1919); but, if an expert, equipped with proper instruments, is not available, esophagotomy without preliminary instrumentation of any kind should be resorted to without delay (Kümmell, 1922; Truesdale, 1924). Nehr Korn (1930) used a posterior mediastinal extrapleural approach to remove a double-edged safety razor blade at the level of the fourth thoracic vertebra. A tube was passed from nose to stomach, the esophagus was sewed in one layer, and the wound was packed with gauze and rubber drains. A fistula appeared and closed at the end of six weeks, but the wound filled completely only after five months. Nehr Korn believed this to be the only successful case of the kind since Enderlen's operation in 1901, but in discussion Kudlek reported the removal by external esophagotomy of a denture which had been impacted at the level of the third and fourth thoracic vertebra for sixteen weeks. In this case there was no fistula. Kudlek remarked that, even though successful, he doubted the advisability of his operation and would recommend morcellation and removal through an esophagoscope in another case. Stegemann, in discussion, said that the razor blade could have been removed safely through a distensible esophagoscope passed downward from a cervical esophagotomy or upward from the stomach. Anschütz (1922) and Perslow (1935) advised the retrograde removal by gastrostomy of large foreign bodies impacted below the sixth or seventh dorsal vertebra if they had been present for some time.

Even after esophagoscopy removal of a foreign body, it is often difficult for an endoscopist to decide whether or not the esophageal wall has been perforated (e.g., see cases of King, 1929). The clinical evidence

*The following instruments have been introduced lately to make easier and safer the removal of foreign bodies from the esophagus: Tucker (1934), a 5 mm. full lumen scope for infants; Broyles (1937), an improved tube for the extraction of open safety pins.

may not be conclusive and in many cases of small perforations it is certain that the patients have gone on to complete recovery with no other treatment than tube feeding for a few days. Even with the clinical and x-ray evidence of cervical and mediastinal emphysema, instances of uncomplicated recovery without operation are not uncommon (e.g., McGibbon and Mather, 1935; Barth, 1938), but in these cases there has been little or no indication of sepsis. The decision for immediate, wide, internal or external drainage may be said to be indicated: (1) when there has been a definite, sudden perforation of the wall of the esophagus by either a foreign body or an instrument; (2) when, following instrumentation, with or without the removal of a foreign body, there is evidence of continued or increasing local or generalized sepsis (see Klestadt, 1928), i.e., rise in pulse rate, temperature and leucocytosis, increasing lower cervical tenderness, or increase in radiopacity or emphysema by x-ray; (3) when a frankly localized abscess becomes evident.

In case of fresh, gross perforation in the cervical region, there is agreement that drainage should be carried out promptly, packing the wound open with gauze, as did Marschik and Vogel (1909) in their cases. By this technique the descent of infection through the areolar visceral and prevertebral spaces to the posterior mediastinum is usually prevented. Pearse (1933) emphasized that the packing should be placed low around the cervical and upper thoracic esophagus before the region of the perforation is entered higher up. If infection has already spread downward into the upper mediastinum, adequate drainage, carried down usually on the right along the path of infection, will often bring recovery (Furstenberg, 1929; Phillips, 1938). Patients should be fed by nasal tube or gastrostomy until all danger of further spreading of the infection is past. Some authors recommend the Trendelenburg position. Phillips irrigated his wounds with dilute solution of chlorinated soda, but the proximity of large vessels and the distinct possibility of hemorrhage from them makes this seem inadvisable. For the same reason, rubber tubes should not be employed.

Posterior mediastinotomy has been uniformly ineffective in the treatment of fresh, gross perforations of the thoracic esophagus. In 1928, Seiffert, confronted at esophagoscopy with a case of recent instrumental rupture in the posterior wall at the level of the clavicles, split the esophagus for about 15 cm. to the lowest extent of the dirty secretion in the mediastinum. A nasal tube for feeding was guided into the stomach under direct vision, the scope was removed, and the patient was placed upright in bed, since he was most comfortable that way. He was much better in two days, and the emphysema disappeared. The tube was removed on the eighth day and the patient was discharged home on the twentieth day. Seiffert observed that the wound granulated cleanly and was later replaced by a narrow linear scar which was more or less fixed to the spine. There was no stricture. Several authors have since recom-

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dysphagia and were not operated upon, under the erroneous impression that the esophagus had not been injured, but they died later of fulminating mediastinitis. This state of affairs led Berger (1915) to recommend that all gunshot and stab wounds of the neck, like all wounds of the abdomen, be explored immediately. Madelung and Berger both advised wide open drainage, the withholding of food and drink, and the prevention, so far as possible, of motions of swallowing. A tube should be passed into the stomach or gastrostomy done. Zeller (1916) added that it is important to prevent the aspiration of blood and mucus into the lungs; tracheotomy is often beneficial. No better advice has been found in more recent literature. Scott (1928) had an interesting experience in a case of extensive cut throat, in which the trachea and esophagus were severed completely. The esophageal stump was pulled out of the upper mediastinum, yet no mediastinitis occurred. The esophagus was sutured and held in spite of the fact that the patient insisted on drinking immediately afterward; dilatations were later necessary. The patient pulled the tracheotomy and gastrostomy tubes out on the sixth postoperative day. Both recurrent laryngeal nerves must have been severed, but the voice later became almost normal. Scott suggested the possibility that deliberate division of the trachea might provide a satisfactory wide exposure of the cervical esophagus when indicated, for example, for the removal of a tumor.

“Spontaneous” Perforation or Rupture of the Esophagus.—Walker (1914) and Popper (1933) described cases in which severe epigastric pain and spasm led to useless exploration of the abdomen; the patients were found to have tension pneumothorax and died shortly in spite of drainage of the pleura. These victims, and about forty others reported in the literature (see Wallach, 1923; Smead, 1931; Gott, 1933; Ridgway and Duncan, 1937), were shown at autopsy to have ruptured the esophagus immediately above the diaphragm. A fresh tear with little or no evidence of previous local disease has been the usual finding, although in Kyle's case (1935) there was a recent inflammatory reaction with polymorphonuclear leucocytes, monocytes, some necrosis, and numerous bacteria, principally streptococci, between the muscle fibers. Most of the patients, a few of whom were convalescents from laparotomy, had had violent attacks of vomiting immediately preceding the onset of acute symptoms, leading to the assumption that the ruptures occurred as the result of sudden increase in the intraesophageal pressure. The patient of Menne and Moore (1921) was only 5 months old. Smead remarked that thoracic pain, dyspnea, cyanosis, emphysema of the neck, and altered physical signs in the chest, following vomiting, should suggest rupture of the esophagus.

Esophagitis, Ulcer, and Stricture.—Mosher (1930, 1931, 1933, 1935) has frequently seen evidence of diffuse inflammation in the walls of the esophagus in patients of all ages, including the newborn. It is his belief

mended Seiffert's method (Kramer, 1929; Vogel, 1932, 1937; Nissen, 1934; Barth, 1938). Vogel saved four patients by this means, one following the excision of a pharyngeal diverticulum and three after perforations by foreign bodies. Meyerson (1928) reported recovery in a patient with emphysema and a high temperature when pus evacuated itself into the lumen after removal of a bone from the thoracic esophagus. In another case gastrostomy was effective following perforation by an esophagoscope in a male, aged 65 years, with carcinoma, in spite of emphysema and a fever of 103°. Meyersburg (1930) records the recovery of a man, aged 60 years, who two days before had swallowed a piece of glass, by the insertion of an esophagoscope through a lacerated area at the level of the clavicles, releasing foul, creamy pus under pressure. The patient was also drained externally by the cervical route and nursed in Trendelenburg's position with a Rehfuß tube in the stomach. Alpin (1931) removed a goose bone which had been lodged six days through a distensible esophagoscope. Pus was seen to exude from a periesophageal abscess. The following day a large amount of streptococcus pus was evacuated by bilateral cervical drainage; recovery followed. Wright (1934) opened a swelling which appeared in the lower left cervical region three days after the removal of a splinter of mutton bone from the left anterior wall of the esophagus, 1 inch below the cricoid bone. This, with gastrostomy, cured the woman, aged 53 years, of an abscess which extended as low as the fifth thoracic vertebra. In another patient, aged 38 years, seen seven days after the onset of symptoms, pus was found exuding from an opening in the anterior wall of the esophagus, 3 inches below the cricoid. A poor prognosis was given but the man went home, essentially well, six days later. Churchill (1935) reported successful drainage of a mediastinal abscess by the posterior extrapleural route. The right third to fifth ribs were resected from the shortened transverse processes to the angles, the pleura was retracted, the mediastinum aspirated and opened just above the azygos vein. Immediately following Phillips' (1938) posterior mediastinotomy, a chylous fistula appeared, but it closed promptly. Other interesting cases were recorded by Moersch and Kennedy (1933).

In King's case (1929), a boy, aged 6 years, who became very ill immediately after the attempted blind dilatation of a stricture, recovered after a gastrostomy and the drainage of an empyema.

Perforations From Without by Bullets and Knives.—During the World War, Madelung (1915) made the significant observation that the men who received extensive shell wounds of the cervical esophagus were more likely to recover than those who were shot by rifles. The large wounds drained freely from the start; whereas, with rifle wounds, the highly infectious esophageal contents spread through the areolar tissues into the mediastinum before release of pressure was afforded by the delayed operations then practiced. Some of the men did not complain of

That external blows may produce lesions of a hemorrhagic and inflammatory nature is evident from the four cases of Vinson (1936), and one of Schmitt (1938).

Eusterman, Moersch, and Camp (1930) and Moore (1930) stated that in their experience ulcerations of the esophagus are almost always superficial. The literature, nevertheless, is full of descriptions of lesions which range from microscopic destruction of the ganglion cells and fibers of Auerbach's plexus in achalasia to the most indurated, obstructing, perforating, and bleeding ulcers. Among Butt and Vinson's 213 cases of esophagitis (1936), demonstrated in a series of 3,032 autopsies, 76.5 per cent were of the acute ulcerative variety, 14.5 per cent were subacute, and 6.5 per cent were chronic. Seventy-four and six-tenths per cent of the cases occurred following operations and in 20.6 per cent vomiting had been frequent or continuous. Hematemesis has been found not infrequent in bedridden patients, especially following operations (Glynn, 1917; Pringle and Teacher, 1919; Lyall, 1935; Bartels, 1935; Polson, 1936). Lyall suggested treatment by frequent small doses of alkali, gum arabic, and olive oil or liquid paraffin by mouth. Brown and Kellert (1933) reported two fatal cases of bleeding from esophageal ulcers in newborn infants.

McClure (1934) recorded a case of uncomplicated esophageal ulcer which was undiagnosed in the hands of many physicians for ten years; during this time an omentopexy had been done for the relief of bleeding, under the impression that the patient suffered from cirrhosis of the liver. Similar difficulties in diagnosis were emphasized by Levine (1929), Pesek (1934), and Hurst (1934). In one of Hurst's patients the gall bladder had been explored and the appendix removed without relief; another "had been called hysterical and was in a deplorable state." The symptoms often mimic those of peptic ulcer of the stomach or duodenum and a quite large percentage of the patients actually have both a duodenal or gastric and an esophageal ulcer (e.g., Pesek, 1934; Winkelstein, 1935; Lyall, 1937). It seems not improbable that the etiologic factors are identical and it has been suggested that the heartburn in peptic ulcer is in fact due to peptic esophagitis (but see footnote on page 623). Jackson (1935) emphasized that in every patient with unyielding gastric symptoms esophagoscopy is indicated.

An extraordinarily large proportion of esophageal ulcers are complicated eventually by hemorrhage, perforation, or stricture. Of seventy-two patients (Roessler, 1935), thirteen died suddenly of hemorrhage, fourteen of perforation. In Christopherson's case (1917) the ulcer perforated the descending aorta. One of Miller's patients (1917), who had suffered from dyspepsia for six years, became exsanguinated in forty-eight hours. Truesdale (1939) reported an autopsy on a young girl who, in spite of repeated transfusions, died of hemorrhage from "multiple minute ulcers at the lower end of the esophagus." A woman,

that this may arise by direct infection through the mucosa or from a more or less distant focus by the blood stream, by the lymphatics, or by continuity. In the newborn the organisms must have been transmitted from the mother. Hemorrhage into the walls of the esophagus has been observed in these infants. Ninety per cent of Jackson's (1929) patients with ulceration of the esophagus showed some focus of infection; whereas, only 15 per cent in a control series of patients without ulceration showed foci. Lerche (1923) cited two cases of ulcer in which the onset was preceded by suppuration elsewhere. Kelly (1936) reported cases of progressive narrowing and shortening of the esophagus with hiatal hernia and suggested that "inflammatory changes have been ascending from the lower end of the gullet and have produced a fibrosis and shrivelling of the walls whereby a reduction in the length and lumen of the affected region has taken place." This condition should be distinguished from the congenitally short esophagus. Gutmann, Moulouguet, and Arnous (1937) and Soulas (1937) ascribed atonic megaesophagus, various irregularities in the walls, and some of the strictures to the effects of primary esophagitis. Roberts (1915) reported two cases of stricture of the esophagus following typhoid fever. Zohman (1933) told of a boy, aged 16 years, a diabetic admitted with acidosis and dehydration, who showed at autopsy a small, sharply-stepped, acute ulcer immediately above the cardia which had perforated into the mediastinum.

Cushing (1932), Light, Bishop, and Kendall (1932), and Watts and Fulton (1935) demonstrated that many of the mucosal erosions which occur in the upper gastrointestinal tract may arise in response to central stimuli mediated through the vagus nerves. Masten and Bunts (1934) noted multiple erosions of the stomach and perforation of the esophagus in a man, aged 28 years, who was being treated for acute encephalitis with marked disturbance of the vegetative nervous system. Fatal hemorrhage from an acutely ulcerated esophagus in a patient with a cerebellar tumor was reported by Craig and Lipcomb (1936).

Many authors consider that ulceration is most common in the lower portion of the esophagus because of the presence of islands of mucous membrane which secrete acid. Ireland (1933), however, is of the opinion that these glands, which appear in the upper third of the esophagus in even greater number than in the ulcer-bearing lower portion (Boerner-Patzelt, 1922; Heine, 1930), probably represent normal esophageal tissue and probably do not secrete acid. Friedenwald, Feldman, and Zinn (1928, 1929) were able to maintain ulceration in the dog's esophagus only by a combination of injury and the frequent feeding of hydrochloric acid. It is their feeling, concurred in by Vanzant (1938), that persistent ulceration in the human being occurs only when the cardia remains patent so that regurgitated acid gastric secretion may continue its corrosive effect. Vinson (1921) observed six cases of stricture of the esophagus following the vomiting of pregnancy.

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was necessary to resect the mass by the abdominal route and anastomose the esophagus to the remaining portion of the stomach. Recovery was complete, but the patient died eighteen months later of strangulation of the small intestine. Autopsy showed a large lumen at the site of anastomosis without stricture or ulcer. Roessler warned that, if operation is to be done in these resistant cases, it should be carried out before the patient has suffered too much inanition and before the wall of the esophagus has lost its tone. Nissen (1937) successfully resected a bleeding ulcer in a male, aged 28 years. Roentgenography showed a large niche in the region of the cardia and at laparotomy a mass was felt which was partly below and partly above the diaphragm. A jejunostomy was done, but the bleeding continued. After three weeks, Nissen removed the left ninth rib, crushed the phrenic nerve, resected the mass, and implanted the ligatured stump of the esophagus into a small opening in the fundus of the stomach by a Witzel-like technique. He sutured the diaphragm around the stomach and closed the mediastinal pleura and chest without drainage and with the lungs expanded. A transfusion was given; there were no complications. X-ray showed good function and the patient was discharged in good condition four weeks after operation.

In cases of suspected carcinoma of the esophagus Eggers (1938) and Whipple (1939) each successfully removed the entire thoracic esophagus by Torek's technique (see section on Carcinoma of the Midesophagus). In Eggers' case there was a chronic, stenosing ulcer, and in Whipple's, a strictured zone of fibrosis with superficial ulceration of the mucosa above it.

Ballin and Saltzstein (1922) reported the occurrence of an esophageal fistula into an empyema cavity in a boy, aged 15 years, following pneumonia. He was fed through a Rehfuß tube and the communication eventually closed, after which the lung expanded, with recovery. These authors referred to Hawes' case in which a lung abscess perforated into the esophagus. Eguen (1924) told of a boy, aged 4 years, with a stricture at the level of the aortic arch due to an old burn with lye, in whom barium ran through the mediastinum into the right upper lobe of the lung. A gastrostomy was provided and the boy was placed in bed on his left side, whereupon recovery occurred. Dilatations were later carried out with some success. Benson and Penberthy (1938) reported the recovery by catheter-cannula drainage and tube feeding of a boy, aged 2 years, in whom tension pneumothorax and empyema were due, in all probability, to the perforation of a foreign body through the wall of the esophagus into the left pleural sac. Milk given inadvertently shortly after operation ran out of the catheter immediately.

Engelstad and Thrane (1936) described a unique occurrence in a male, aged 52 years, from whom a large piece of meat was removed from the lower esophagus through an esophagoscope. The meat had caught because of a mass of swollen, indurated, infected tissue which on biopsy

aged 62 years, under the care of Sunde (1937), bled severely from a moderately indurated ulcer, but improved under medical management. A patient of Stewart and Hartfall (1929) had complained of pain high in the epigastrium for five months and of recurrent hematemesis for 2 weeks. Death was due to perforation of an ulcer on the posterior wall just above the cardia into the right pleural sac. On the anterior wall directly opposite the perforation was the scar of a large healed ulcer.

The serious complications which may arise in patients with esophageal ulcer appear to demand new efforts toward early diagnosis and effective treatment. The removal of foci of infection, the control of acidity by medical means, the administration of atropine or papaverine to control spasm, the topical application of silver nitrate, dilatations, and rest of the part by an inlying tube or gastrostomy are accepted as the best measures for treatment of uncomplicated, bleeding, or stenosing ulcers (e.g., Sheehan, 1920; Anschütz, 1922; Aurelius, 1931; Nissen, 1934; Roessler, 1935; Decker, 1936; Vanzant, 1938). It may be necessary to carry out treatment for several years in order to bring about a remission or cure. However, Fleischner (1927) noted prompt symptomatic and roentgenographic improvement following gastrostomy in his case. Barclay (1915) relieved his patient by the ionization of zinc at the site of the ulcer. In the strictured cases with little activity of the ulcer dilatations are very effective (e.g. Lerche, 1923; Benedict and Daland, 1938).

A few cases of esophageal ulcer, for the most part those of long standing which have resisted dilatation, have been treated more radically by operation. In a patient with a callous, stenosing ulcer of the lowermost portion of the esophagus, Pesek (1934) mobilized the cardia, made a longitudinal incision through the narrow region, and sutured it transversely over an inlying tube. The patient died one month later. Zaaier (1932) recorded two successful "Finney pyloroplasty" operations for benign strictures of the lowermost portion of the esophagus. He mobilized the esophagus, sutured the fundus of the stomach to it over a broad area, then from within the stomach incised the spur thus formed, providing a wide new opening (see discussion of other operations of this kind under the section on Achalasia of the Cardia). Roessler (1935), in a report from Sauerbruch's clinic, described one fatal and one successful transthoracic esophagogastrostomy carried out with the purpose of shunting food past an ulcer. In the fatal case death occurred from empyema complicated by cerebral abscess. In the successful attempt the patient was free from symptoms six months after operation. Sauerbruch (see Roessler, or Krauss, 1933) went a step further in another patient whose symptoms persisted following a jejunostomy and an esophagogastrostomy which failed to function. Returning to the lesion by way of the thorax, he invaginated the whole mass into the stomach with the expectation that it would slough off. This failed to occur and finally it

burn, dilatations must be carried out. Lerche (1915) reproduced an illustration of Jameson's (1825) esophageal sound which was passed on a swallowed string. Jameson's important contribution has been skillfully adapted to many varieties of esophageal instrumentation, in this country notably by Plummer (1910), Vinson (1924), and Tucker (1924). Capelle (1918) and Tucker, by means of his own bougies, utilized von Hacker's method of retrograde bouginage on a continuous string for the dilatation of narrow strictures. Mosher (1936) fashioned special instruments for fluoroscopic bouginage in selected cases. Hoag (1937) described an ingenious method of dilatation by the use of Levine tubes and ordinary catheters of gradually increasing size. Kummant (1932) reported a simple maneuver for quickly picking up, through a gastrostomy, a ureteral catheter which has been passed down from the mouth on a swallowed string.

Occasionally, it has been found impossible by ordinary methods to get a string or an instrument through the tortuous channel of a strictured esophagus. Rarely the stricture is actually impermeable, although more often it is only apparently so (Zaaijer, 1932; Demel, 1933). Lotheissen (1926) has taken advantage of the Prussian blue reaction to determine this. Even when the chemical test indicates impermeability, instruments have sometimes been passed eventually with comparative safety. One of the best procedures for this purpose appears to be Iglauer's (1932), used also with success by Zaaijer (1932), Carroll and Myers (1937), and Freiberg (1937). Iglauer passed a cystoscope through a gastrostomy, filled the stomach with water, entered the esophagus, and under visual control passed a ureteral catheter through the strictured area up to the mouth. When the channel has been particularly difficult to find, or if there is actual impermeability, double esophagoscopy under the control of biplane fluoroscopy has resulted occasionally in safe perforation of a short stenosed zone (e.g., King, 1924; Jackson, 1931).

In the quite rare instances in which it is found impossible by any safe means to pass a string or instrument through the esophagus, an antethoracic esophagus may be constructed. Since the original efforts of Roux (1907), many varieties of operation have been carried out in an effort to provide a living tube, without fistula or stricture, which will bridge the gap between cervical esophagus and stomach. All of the procedures are time-consuming and somewhat dangerous, but the esophagoderματοjejuno-gastrostomy of Lexer (1911) the operation most used at present, has proved quite satisfactory from the standpoints of technique and of function in the hands of a number of surgeons (e.g., Petersen, 1921; Wiedemann, 1928; Oulié, 1929; Strähle, 1931; Ochsner and Owens, 1934; Grégoire, 1934; Lob, 1936; Mullen, 1936). Rovsing (1925, 1926) described several successful esophagodermatogastrostomies, but the union of skin to gastric mucous membrane is likely to result in

showed nonspecific chronic inflammation. Later, roentgenograms with barium showed a communication with the gastrohepatic omentum or the lesser peritoneal sac. The patient recovered without operation and studies two months later demonstrated a niche where the perforation had occurred but no evidence of other pathology and no retention. This was presumably a case of silent ulcer of the esophagus with perforation below the diaphragm.

Corrosive Burns.—Because of the persistence of Chevalier Jackson (1910, et seq.), a Federal law to assure the proper labeling of caustic alkalies was passed in 1927. This act, together with education of the public, appears to have resulted in a decrease of more than 50 per cent in the number of corrosive burns of the esophagus in Pennsylvania, Florida, and Colorado, where reports are available. The reduction has occurred in spite of the increasing use of lye preparations and is gratifying, although efforts to improve the situation further should be persisted in (Taylor, 1935).

Salzer (1920, 1934) urged early bouginage, beginning between the second and sixth day after the swallowing of a caustic, in an effort to prevent adhesions between the walls of the esophagus which would later result in strictures. Among 180 patients so treated, 163 were cured so that they could swallow solid foods in a normal manner. In only three instances was the esophagus perforated by the flexible, shot-filled, No. 30 bougie which he used. Salzer was particularly successful by this method in the treatment of children. However, the experiments of Belinow (1935) on dogs appeared to show that nothing is to be gained by separating the walls of the esophagus before the seventh to tenth days, because exfoliation continues during this time and surface fibrosis does not begin until the stage of exfoliation is completed. Furthermore, according to Campián (1928), it is dangerous to pass bougies until the macerated walls have regained some of their strength. Belinoff (1930) recommended, for the first seven to ten days, the injection of olive oil into the esophagus. This served for feeding and made the passage of bougies later on much easier. The method of early bouginage has been accepted by Phelps (1938), among others, but many esophagoscopists feel that they obtain as good results more safely if they delay bouginage until the seventh to fourteenth days (e.g., Equen, 1924; Lotheissen, 1937). Treer and Falta (1935) placed emphasis on the importance of putting the esophagus at absolute rest by very early gastrostomy. Gastrostomy without bouginage to keep the esophagus open is to be condemned, however. In Salzer's splendid series, which in spite of all criticism demands the most earnest consideration, it was necessary to perform gastrostomy in only three cases, and the patients almost uniformly maintained excellent nutrition throughout their illnesses.

If, by early management with rest and bouginage, the esophagus does not return to its normal function within two months after a chemical

bors a localized lesion in a patient who is free or almost free of tuberculosis elsewhere. Jackson (1929) spoke of primary tuberculosis as a superficial, whitish or grayish ulceration with no surrounding hyperemia. Such a lesion, in the experience of Torek (1931), however, was extensive enough to cause obstructive dysphagia near the cardia, in a male, aged 69 years. The lungs showed only questionable healed tuberculosis at the right apex and the sputum was repeatedly negative. A somewhat similar situation was described by Lévy and Gally (1932) in a diabetic woman, aged 72 years, whose dysphagia of six month's duration was found to be due to a partially constricting, irregular process which extended from the level of the sternal notch to behind the heart. The radiograph showed a double contour, indicating thickening of the wall of the esophagus; the lungs were normal. At esophagoscopy there was seen a white, fibrous, immobile fold without visible ulceration. A biopsy revealed a typical tuberculous lesion and Ziehl's stain showed the bacilli of Koch. In the case of Incze (1934) autopsy demonstrated miliary tuberculosis, with an old, chronic tuberculous lesion in the wall of the esophagus as the only apparent source.

Jackson (1929) mentioned the occurrence of ulceration of tuberculous mediastinal lymph nodes into the esophagus. Galavotti (1934) described two cases of this nature, in one of which caseating retroperitoneal nodes had also invaded and ulcerated the duodenum. In both cases tubercle bacilli were found within the lymph nodes and in the involved portions of the esophageal walls.

Actinomycosis of the esophagus must be exceedingly uncommon. In the only recent reference to the disease Jackson and Jackson (1933) reported an instance of actinomycosis of the lung which appeared to have spread from a lesion in the esophagus. Garde (1896) noted four primary and two secondary cases in the human being, and Bartlakowski (1930) mentioned a case of surface infection in a monkey.

Still rarer is the occurrence of blastomycosis of the esophagus, even in disseminated cases, and the only known primary infection was described, in 1928, by Vinson, Broders, and Montgomery.

(To be concluded in the December issue. The references will accompany the last section.)

ulceration, stricture, and a fistula. However, Wendel (1929) used this technique with satisfaction in a patient whose jejunum was not available for Lexer's operation due to adhesions and a short mesentery. Dengel (1930) obtained a good result by a modification of Jianu's (1912, 1914) operation.

Lundblad (1934) reported on a boy on whom an esophagocolonogastrostomy was performed twenty-one years before, at the age of 3 years, for a complete stricture due to the swallowing of lye. He noted that the transplanted colon had kept pace in growth with the body as a whole. Although a slight fistula had persisted, the tube functioned perfectly and the boy was essentially well.

Specific Infections.—Of the specific inflammatory diseases of the esophagus, tertiary syphilis is most frequently reported. In most of the cases the evidence on which the diagnosis is based is largely serologic and therapeutic, but there is no doubt but that the lesion is a real one and should be kept in mind, particularly in the differential diagnosis of carcinoma (McMahon, 1923; Abel, 1928). Abel stressed the importance of repeated biopsies to rule out carcinoma in cases in which the question of syphilis might have been raised. The two lesions have been known to occur together. Morgan (1938), at autopsy on a colored male, aged 50 years, reported finding a gummatous mass which involved the diaphragm and the adjacent portion of the esophagus. Although serologic evidence of syphilis had been obtained, antisiphilitic treatment and dilatations had not been provided because the lesion was considered to be carcinomatous. Nehrkorn (1930) recorded the cure of a patient, who had been thought at operation to have an inoperable carcinoma of the upper stomach and lower esophagus, by gastroenterostomy, a Witzel gastrostomy, sounding on a continuous string, and anti-siphilitic treatment.

Guyot (1931) found fifty-seven cases of syphilis of the esophagus reported in the literature. Among these, eleven had been confirmed at autopsy, fifteen had been recognized at esophagoscopy and had been cured by specific treatment, and fourteen had been improved by anti-siphilitic therapy without other confirmation of the diagnosis. More recent cases were cited by Jackson and Jackson (1933), Watson-Williams (1933), Wilcox (1934), and Avery (1936). Nissen (1934) recommended antethoracic esophagoplasty in cases of syphilitic stricture which remained impermeable after gastrostomy and antisiphilitic treatment. Abel (1928) mentioned the frequent, but clinically insignificant, involvement of the esophageal mucosa in secondary syphilis and the rare occurrence of the congenital form. Mosher (1935), on the other hand, remarked that in a children's hospital it is not uncommon to find malformations of the esophagus which are due to congenital syphilis.

The esophagus is not commonly the seat of tuberculosis, even in patients who continually swallow the organisms. Still more rarely it har-

is obtained by an extremely small light and light carrier placed in a canal similar in construction to the Negus "suckling" bronchoscope. Because of the small size of the light and light carrier, a significant decrease in size of the outer dimension of the instrument is possible, facilitating its use in the air and food passages of the newborn.

Several case reports were presented.

David H. Jones, New York, N. Y., discussed the treatment of a 2-year-old child who had swallowed a caustic, drano. A No. 12 Levine feeding tube was passed into the stomach two hours after the accident. The child received nourishment through the tube. A number of complications occurred during the treatment. The child developed bilateral swelling of the glands of the neck and otitis media. A gastrostomy eventually had to be done. A laryngotracheobronchitis, which developed during the course of treatment, necessitated a tracheotomy. Therapy of the caustic strictures of the esophagus was carried out by gradually increasing the size of the feeding tubes. The child eventually recovered.

Harris P. Mosher, Boston, Mass., stressed the frequency and importance of inflammatory disease at the lower end of the esophagus in systemic disease. Completed examination of ten of a series of 100 patients who died of unrelated causes demonstrated two with periesophageal abscesses in the distal portion of the esophagus. The first patient, a female, died of lobar pneumonia. The second, an 85-year-old male, died of carcinoma of the prostate.

John F. Delph, Chicago, Ill.: **Hemoptysis During Menstruation—Bronchoscopic Observations.**—In a case of hemoptysis recurring on the second day of each menstrual period for eight months, Delph found a bleeding point consisting of a prominent vessel on the posterior wall of the left main bronchus. It was cauterized with 20 per cent silver nitrate. There has been no recurrence of the symptom for two and one-half years. The increase in capillary fragility during the menstrual period was discussed as a possible etiologic factor.

Ellen J. Patterson, Pittsburgh, Pa., presented a report of a 3-year-old child with multiple papillomas of the larynx, trachea, and left bronchus. Laryngeal papillomas had been previously removed, but recurring dyspnea required tracheotomy. The larynx was again freed of the papilloma, but repeated lower bronchoscopies were necessary to clean the trachea and bronchus. The disease has been benign and self-limited; the child recovered and has a normal larynx.

Rudolph Kramer, New York, N. Y.: **Myoblastoma of the Bronchus.**—Kramer reported the case of a young girl with an atelectasis of the right lower lobe due to a tumor of the right lower lobe bronchus. The tumor, removed bronchoscopically with punch forceps and diathermy, proved to be a myoblastoma.

The following papers were read: **Ethan Flagg Butler**, Ithaca, N. Y.; **N. S. Lincoln**, Mount Morris, N. Y.; **R. Horton**, Albany, N. Y., and **John K. Deegan**, Ithaca, N. Y.: **Late Results of Foreign Bodies Long Retained in the Lower Airways.**—Nine cases of foreign bodies in the bronchi of several years' duration were presented with a discussion of the causes for the delay in recognition, the resulting pathology, the treatment, and end results.

Butler and co-workers state that the pathology produced by foreign bodies constitutes 0.5 per cent of thoracic surgery and is present in 1.5 per cent of admissions to tuberculosis hospitals. Analysis of the factors responsible for a de-

Review of Recent Meetings

THE TWENTY-SECOND ANNUAL MEETING OF THE AMERICAN BRONCHOSCOPIC SOCIETY*

PAUL HOLINGER, M.D., CHICAGO, ILL.

THE Twenty-Second Annual Meeting of the American Bronchoscopic Society was held May 26, 1939, at the Westchester Country Club, Rye, N. Y., President John D. Kernan, New York, N. Y., presiding.

The name of the Society was changed from the American Bronchoscopic Society to the American Broncho-Esophagological Association.

The President's Address consisted of a review of the present status and recent advances in the field of bronchology, with a discussion of some of the unsolved problems in this field.

Kernan stressed the bronchoscopic diagnosis and treatment of lung abscess. The use of irrigating, sulfanilamide, and zinc peroxide solutions, and solutions designed to shrink the mucosa, such as adrenalin and saline, to permit better drainage were mentioned. These procedures under the fluoroscope may be of definite value in specifically localizing and directing therapy.

Kernan, in commenting on the rapid increase of tuberculous tracheobronchitis, questioned whether this is due to more accurate diagnosis or to collapse therapy being instituted so universally. He suggested the use of mercury vapor lamps to promote better healing with less scar tissue formation than that which follows the use of silver nitrate. Dilatation of strictures, furthermore, is not without its ill effects. The mechanical trauma which accompanies the dilatation must be considered in autoinfection with the spread of the disease following bronchoscopy.

In regard to tumors, Kernan discussed adenomas of the bronchus which, with the slightest manipulation, bleed, sometimes uncontrollably. He suggested roentgenotherapy preliminary to further endoscopic therapy as an aid in reducing the operative hemorrhage. It is then possible at times to destroy the growth with electrocoagulation. Of the malignant growths, he believed endoscopic therapy to be only palliative and to consist of the implantation of radon seeds into the tumor. He stressed the need of further experimental work in this field and constant work with animals which is necessary to develop and maintain skill and to overcome difficulties and prevent failures.

In the presentation of new instruments, Gabriel Tucker, Philadelphia, Pa., presented a new instrument for the dilatation of the hiatal esophagus, consisting of a combination of the Hurst mercury bougie with the Mosher pneumatic bag placed near the distal end. The weight of the mercury bougie carries the bag into position for inflation. Tucker presented representative cases treated with excellent results by means of this dilator.

Paul Holinger, Chicago, Ill., presented a new infant bronchoscope and esophagoscope, miniatures of the regular Jackson type of instruments. Distal illumination

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*The articles reviewed here will appear in entirety in the *Annals of Otolaryngology and Laryngology*.

is obtained by an extremely small light and light carrier placed in a canal similar in construction to the Negus "suckling" bronchoscope. Because of the small size of the light and light carrier, a significant decrease in size of the outer dimension of the instrument is possible, facilitating its use in the air and food passages of the newborn.

Several case reports were presented.

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Butler and co-workers state that the pathology produced by foreign bodies constitutes 0.5 per cent of thoracic surgery and is present in 1.5 per cent of admissions to tuberculosis hospitals. Analysis of the factors responsible for a de-

layed diagnosis showed the most important one to be the overlooking or disregarding of a definite history of the foreign body accident, or the failure to elicit a positive history subsequently recalled or admitted by the patient. Second in importance was failure or delay in securing x-rays; and third, a misinterpretation of roentgenograms. In one instance neither the history nor the roentgen findings indicated a foreign body, yet the pathologic examination of a surgically removed lobe revealed a sliver of wood in the bronchus. The foreign bodies in the other eight patients were: timothy heads, 2; nails, 2, one of thirteen years' and one of ten weeks' sojourn; one each of a screw cap, a piece of sponge rubber, a bead, and an open safety pin present three years and complicated by an empyema.

The authors divide patients into four groups: (1) nonobstructing foreign bodies producing no pathologic damage; (2) bronchial obstruction with acute suppuration and pneumonitis; (3) obstruction followed by chronic suppuration and bronchiectasis; and (4) peripheral foreign bodies producing lung abscesses. They base their surgical indications on this classification. The nonobstructing foreign bodies producing no pathologic damage require no surgical intervention. When the prolonged residence of an obstructing foreign body has produced a chronic suppuration and bronchiectasis, the authors conclude that every effort should be made to give adequate bronchoscopic drainage, and then, if feasible, surgically to eradicate the disease. In peripheral foreign bodies which have produced lung abscesses, excision of the lobe is indicated. The greatest therapeutic problem exists in obstruction with acute suppuration and pneumonitis.

Of the nine patients presented, five are living and well; four died either as a result of the foreign body or following surgery.

Mervin C. Myerson, Brooklyn, N. Y.: Tuberculous Ulcerogranulomatous Bronchitis.—Myerson states that the active stage of tuberculous tracheobronchial disease is the ulcerogranulomatous form. Of 236 patients with pulmonary tuberculosis examined bronchoscopically, forty-three had this type of tuberculous lesion and fifteen demonstrated other types of tracheobronchial tuberculosis. The pathogenesis may be by two routes: by continuity from a caseous pulmonary lesion of the parenchyma or by extension from lymphatic glands. The tracheobronchial disease tends to begin in the periphery and to progress toward the larynx. Myerson describes four stages of the pathology. In his experience almost all the lesions begin as a continuation of the pulmonary lesion, with a subepithelial extension of the tuberculous process. A round-cell infiltration below the level of the normal mucosa is followed by an ulceration of the overlying mucosa and by the ulcerogranulomatous lesion of the surface. The final stage is fibrosis, with stenosis of the bronchus produced by the scar tissue contraction. Bronchoscopically, the ulcerogranulomatous lesions appear pale, gray, irregular, and corrugated, and often obstruct the bronchial lumen.

The most constant symptom is rough noisy breathing or a wheeze, often associated with partial or complete bronchial obstruction, simulating a foreign body or a neoplasm. The sputum may be positive, although the peripheral lesion be kept under control by some form of collapse therapy. From the roentgen picture it is impossible to note the spread of the disease along the tracheobronchial tree unless the lesion completely obstructs the bronchus.

Myerson extends the indications for bronchoscopy in pulmonary tuberculosis, stating that it should be done routinely prior to thoracoplasty or artificial pneumothorax. It may even be advisable in patients with pulmonary tuberculosis who are not too sick from the disease. Evidences of bronchial obstruction, such

as wheezing and unexplained atelectasis, are, of course, indications for bronchoscopy, as is an unexplained hemoptysis with positive sputum or spread of the disease.

Treatment of tuberculous lesions of the trachea and bronchi is frequently unsatisfactory because of their extent. In the tracheobronchial tree the most common site of the lesion on the left side is on the superior wall; on the right side, usually the lateral wall; in the middle lobe orifice, the anterior wall.

Ben L. Bryant, Los Angeles, Calif.: A Consideration of the Reflex Etiology of Cardiospasm.—The author, in reviewing the theories of the etiology of cardiospasm, states the disease is not at the cardia nor is it a spasm. He reviews as an etiologic factor the action of the crura of the diaphragm. The theories of the lesion being congenital, psychogenic, or due to compression of surrounding structure are presented. Discussing the underlying neurogenic mechanism, Bryant mentions the degenerative changes in the ganglionic cells of the Auerbach plexus. Several cases presented illustrate the etiologic significance of pathologic conditions elsewhere in the gastrointestinal tract. Although the author does not intend to place all so-called cardiospasm on a reflex basis, the cases cited support the theory "that anything which unduly disturbs the reflex arc of the myenteric plexus may serve as an inciting cause of functional stenosis of the esophagus."

Samuel Iglauer, Cincinnati, Ohio., and Wm. F. Molt, Indianapolis, Ind.: Laryngeal Stenosis Following the Use of Levine Feeding Tubes, With Report of Cases.—The authors report ten instances in which severe injuries to the larynx occurred following the use of Levine feeding tubes kept in situ from six to fifteen days. In eight of these the stenosis became so acute that tracheotomy was necessary. Pain deep in the throat was the outstanding symptom, patients frequently complaining that the pain extended to the ears. Dysphagia, blood-streaked sputum, and hoarseness were present in almost all cases. Preceding the tracheotomy, an increasingly irritating cough followed by severe dyspnea were the symptoms and the laryngeal picture was that of a subglottic edema which rather rapidly became more acute and frequently was associated with fixation of one or both of the arytenoids. A pressure necrosis of the esophagus over the cricoid cartilage was found in two cases at post mortem. The ulceration and acute subglottic stenosis or fixation of the arytenoids, characteristic in the series, were demonstrated also at autopsy. A sphincter-like action of the muscles of the hypopharynx apparently had pressed the tube onto the cricoid cartilage. This, with swallowing and vomiting, led to a perichondritis of the cricoid cartilage followed by the characteristic subglottic edema and stenosis. In one instance the tube had been present eight days. The dyspnea, beginning five days following its removal, gradually increased the subsequent ten days until tracheotomy became necessary. In the second patient an irritation developed in the throat two days after the insertion of the tube which was left in place fifteen days. Tracheotomy was required on the thirteenth day.

Thomas R. Gittins, Sioux City, Ia.: The Acute Chest From the Bronchoscopic Standpoint.—Gittins points out that the value of bronchoscopy in acute pulmonary disease is diagnostic and therapeutic. He emphasizes it as an adjunct to the usual methods of auscultation, percussion, and the *roentgenologic studies* of the chest, limiting his discussion to facts established by its use. He points out the confusing similarity between pneumonia and atelectasis, and the importance of early recognition of their differential diagnosis. As mechanical obstruction, such as is caused by foreign bodies, produces an atelectasis and, later, a bronchiec-

tasis, early correct diagnosis with the subsequent bronchoscopic treatment is stressed and is illustrated by a series of cases. The author cites ball valve obstructive emphysema as one of the least understood and most misunderstood of acute symptoms of pulmonary pathology. He mentions the extremely acute infections which accompany certain foreign bodies, such as aspirated corn or peanut candy. An allergic sensitivity to peanuts may possibly be responsible for the acute reaction. The value of bronchoscopy in the aspiration of obstructing mucopurulent secretions in postoperative massive collapse of the lung is stressed, with illustrative cases. Another type of acute pulmonary disease requiring endoscopic management is associated with laryngeal obstruction and a descending infection; namely, an acute laryngotracheobronchitis. It often is accompanied by atelectasis and may be confused with bronchopneumonia.

E. N. Broyles, and Gilbert E. Fisher, Baltimore, M.D.: Bronchoscopic Experiences With Lung Tumors.—The symptoms, signs, and diagnostic methods used in establishing the diagnosis in sixty-five cases of primary bronchial tumors are analyzed. The figures of the increasing incidence of bronchogenic carcinoma are quoted, this disease constituting 8 per cent of carcinomas in males and 2.5 per cent of carcinomas in females. The disease is five times more common in the male. Of the series, fifty-four patients were males, 11 were females. The age incidence was between 40 and 50 years. No relation to the occupation of the patient could be correlated. The disease was found 5.5 times in white people to 1 in negroes. Sixty-five per cent were squamous cell carcinomas; the next most common type was adenocarcinoma. The value of bronchoscopy in establishing the diagnosis is stressed. In fifty-three, or 90 per cent, of the authors' cases, the diagnosis was made by bronchoscopic biopsy. A positive diagnosis was made in 92 per cent of the cases in which bronchoscopy was employed in addition to roentgen studies. The symptomatology of these sixty-five patients was varied, but the commonest symptoms were fever, cough, pain, and hemoptysis. In discussing therapy, the authors state that the squamous cell type of tumor is highly resistant to roentgen therapy, but the tumor remains fairly well localized and metastasizes late. It consequently offers the best outlook for response to surgery. Surgical excision of the lung is the therapeutic procedure of choice, coagulation of the growth, roentgen ray, or radium being of no appreciable help except in isolated cases.

Waitman F. Zinn, Baltimore, Md.: The Biplane Fluoroscope as an Aid in the Removal of Foreign Bodies From the Lungs.—Zinn presented two illustrations of the importance of biplane fluoroscopy as an aid in the removal of foreign bodies from the lung. He pointed out that, although biplane fluoroscopic assistance is indispensable in certain types of cases, it is not an easy short cut for the removal of foreign bodies. The first patient, an 8-year-old boy, had aspirated a .22 caliber bullet. Several unsuccessful attempts elsewhere at removal bronchoscopically further complicated the case. The foreign body was removed with fluoroscopic assistance and guidance. The second patient, a 45-year-old male, had complained of hemoptysis seventeen years. The history and roentgenograms were negative for foreign body. Careful roentgen examination revealed a lead fishing sinker in the base of the right lung, present forty years. Hemoptysis was severe enough to necessitate transfusion. The foreign body was removed with biplane fluoroscopic guidance.

Emmett T. Gatewood, Richmond, Va.: Certain Phases of Respiratory Failure.—Gatewood reports two cases of respiratory failure following the successful reestablishment of the airway. The first, a 21-year-old male with Ludwig's an-

gina, required an emergency tracheotomy because of an extreme dyspnea. On opening the trachea, the lumen was found to be dry and a tube was inserted. The patient breathed eight to ten times through the cannula, then suddenly expired, the successful tracheotomy being followed immediately by respiratory failure. In the second patient a large aneurysm caused distortion and compression of the trachea, but the stenosis was relieved by the insertion of a rubber tube through the tracheotomic cannula, beyond the area of stenosis. The patient died, however, despite the restored airway.

To study these phenomena and to evaluate the resuscitative measures, Gatewood induced varying degrees of obstructive asphyxia in forty-two tracheotomized dogs. In the first group an obstruction was permitted for twenty-four hours, the tube being obstructed 75 per cent or more until dyspnea occurred. As carbon dioxide was accumulated in the arterial blood, the respiratory mechanism was stimulated. A sudden release of the obstruction resulted in overventilation, the carbon dioxide being washed out rapidly by the deep, rapid breathing. During the period of obstruction, the total arterial carbon dioxide tension decreased, the average increase in the pH being 1.2. In the experimental animals no indications of respiratory failure followed the release of the obstruction. The hyperpnea resolved and the breathing returned to normal in a short time.

REVIEW OF THE MEETING OF THE AMERICAN ASSOCIATION OF OBSTETRICIANS, GYNECOLOGISTS, AND AB- DOMINAL SURGEONS, SEPT. 7, 8, AND 9, HOT SPRINGS, VA.

RICHARD PADDOCK, M.D., ST. LOUIS, MO.

(From the Department of Obstetrics and Gynecology, Washington University School of Medicine)

THE fifty-second annual meeting of the American Association of Obstetricians, Gynecologists, and Abdominal Surgeons was held at The Homestead, Hot Springs, Va., Sept. 7, 8, and 9, 1939. The meeting was well attended by members of the society and their invited guests. Out of the seventeen listed papers, sixteen were presented.

Walter B. Mount, Montclair, N. J.: *An Electric Timer: an Aid in Counting the Fetal Heart in the Second Stage of Labor and Timing Forceps Traction.*—He stressed the importance of observation of the fetal heart during labor. Slides of various types of face masks were shown. Types of the head stethoscope were demonstrated, including the Leff stethoscope. Demonstrated also were electrical aids in amplifying or recording the fetal heart. He discussed fetal electrocardiography, its uses and limitations. The Wachenfeldt signal clock and electric timer for use with the head stethoscope and for spacing and timing forceps traction was described. A bell sounds at intervals of 15 seconds, 30 seconds, or 1 minute, serving a double purpose to time fetal heart and intervals between tractions.

Samuel A. Cosgrove, Jersey City, N. J., in discussion stated that fetal chance should be improved with safety and that frenzied interference is inadvisable. **Frederick H. Falls**, Chicago, Ill., in discussion considered the importance of the timer and head stethoscope. **William Wayne Babcock**, Philadelphia, Pa., showed a stop watch that gives direct reading of rate on the dial after thirty beats are counted.

Otto H. Schwarz and **S. D. Soule**, St. Louis, Mo.: **Blood Lipids in Pregnancy.**—Dr. Soule presented the paper. This consisted of a preliminary report on the determination of the blood lipids in normal pregnancy. The trend of increase of the blood lipid concentration was followed by a complete lipid study at monthly intervals on normal pregnant women without special supervision other than the regular prenatal care. By charted curves and tables the authors showed the increase of lipids and their concentration at term.

E. D. Plass, Iowa City, Ia., in his discussion brought up the significance of lipemia and commented on the value of the data presented by the authors. He also remarked of the question of hepatic malfunction. **James Ethelbert Davis**, Ann Arbor, Mich., considered the question of the relation of increase in blood lipids to the increase in gonadotropic hormone. **James R. Bloss**, Huntington, W. Va., in the discussion mentioned the basal metabolic studies in the pregnant woman.

W. R. Barney, Cleveland, Ohio: **Treatment of Hemorrhagic Disease of the Newborn.**—Dr. Barney stated that the term is purely a descriptive one. Etiology is not known. He outlined the various theories advanced and the recent investigations in vitamin therapy, such as increasing the maternal vitamin intake during pregnancy, as well as administration of vitamin K to the child. No characteristic pathology is found. Prognosis is good if treated early. The best treatment is intravenous blood. Anticoagulants and serums give poor results. A summary of 41 cases with comparative results with no treatment, intramuscular blood, and intravenous blood was given. Dr. Barney advises against the use of longitudinal sinus.

Richard Paddock, St. Louis, Mo., in discussing the paper of Dr. Barney, stressed the necessity of immediate treatment. He quoted miraculous results with intravenous blood and cited the fatal effect of piercing longitudinal sinus in transfusion. **Thomas B. Sellers**, New Orleans, La., discussed uses of diet in prophylaxis of hemorrhagic disease, as well as use of vitamin K and whole blood in the treatment.

James K. Quigley, Rochester, N. Y.: **Maternal Welfare Work—What Are Its Fruits?**—He outlined some of the fruits of prenatal care and the nature and scope of the work being done. For the first time in many years the maternal mortality rate of the United States shows a substantial decline. Questionnaires sent to state health departments and state medical societies revealed the fact that much maternal welfare work has been done in the past ten years. This, Dr. Quigley believes, has been in large measure responsible for the improved conditions. His suggestions for the future include the warning that the work, while meeting with encouraging results, is only begun and must be continued.

This paper caused considerable comment by way of discussion by the following: **Fred L. Adair**, Chicago, Ill., gave a summary of the campaign of maternal welfare over twenty-seven years. **N. F. Paxson**, Philadelphia, Pa., outlined the

work in Philadelphia and the reduction in maternal mortality, giving credit to Dr. Philip Williams. He stressed the importance of interchange of ideas among obstetricians who are interested in reduction of maternal mortality. A. W. Bingham, Jersey City, N. J., quoted favorable results since 1923, and pointed out the importance of coordination of various agencies. His discussion was accompanied by lantern slides showing statistics. R. E. Seibles, Columbia, S. C., mentioned that approximately one-half of the births in South Carolina were attended by physicians and one-half by colored midwives. One problem there is better training of midwives and attempts at elimination of unfit midwives. In South Carolina it is largely a rural problem. There has been a 30 per cent reduction in mortality in five years. Irving W. Potter, Buffalo, N. Y., outlined the plan there. Frederick H. Falls, Chicago, Ill., made mention of the necessity of appeal for the support of the various state societies. R. L. DeNormandie, Boston, Mass., spoke of the importance of the proper type of consultation where consultation is required. George F. Pendleton, Kansas City, Mo., considered how any plan for maternal welfare work should be adapted to the local community. J. Bay Jacobs, Washington, D. C., discussed the program there. James R. McCord, Atlanta, Ga., spoke of factors tending to produce or decrease maternal mortality rate. LeRoy A. Calkins, Kansas City, Mo., brought up several points for consideration in the maternal welfare program.

Bayard Carter, Durham, N. C.: **Vulvo-Vaginal Mycoses in Pregnancy With Relation of Symptoms to Genera and Species of Fungi.**—An outline of the positive cultures for yeastlike fungi taken from the vagina, labia, or both areas in 86 out of 200 pregnant women was shown. This study included a complete history of evidence of mycologic infection, vaginal examinations, agglutination with patient's serum, intradermal skin test smears, hanging drop and classification of the fungi. Attempts were made to correlate the species and genera of the fungi with the patient's history and clinical findings. Lantern slides and tables were shown.

P. Brooke Bland, Philadelphia, Pa., in his absence submitted his discussion, which was read. Results similar to those of Dr. Carter were obtained in the clinic of Dr. Bland. Alonzo K. Paine, Boston, Mass., was on the program of discussion. A. N. Creadick, New Haven, Conn., stressed conclusions drawn from work done. He mentioned some factors inducing susceptibility in patients. E. D. Plass, Iowa City, Ia., considered changes in physiology of the vagina that permit pathologic manifestations of the mycotic infections, mentioning a number of practical points. Archibald D. Campbell, Montreal, Quebec, spoke of some considerations of the subject.

The Joseph Price Oration, a feature of the program, was given by J. B. Collip, of Montreal, Quebec, who spoke on **The Pituitary Gland in General and Sex Hormones in Particular.**

In this comprehensive talk Dr. Collip covered the effect of pituitary extracts on hypophysectomized animals. The effects vary depending on the method of extraction of the anterior lobe. He outlined the effect on growth, as well as the thyrotrophic effect, the suprarenal cortical effect, and the effect of gonadotrophic hormones as well as the prolactin effect. Evidence of the peripheral effect of thyrotrophic extract of the anterior pituitary was shown; namely, the immediate effect with the quick increase in metabolic rate.

Of the gonadotrophic substances, the three principles or types were enumerated:

- Chorionic gonadotrophin
- Pituitary gonadotrophin (pituitary origin)
- Follicle stimulating
- Luteinizing
- Mare's serum gonadotrophin

The differences in the various substances in effect were mentioned. In general, they all produce the same type of reaction in immature rats. The mare's serum type is most stimulating. Chorionic gonadotrophin is less active. The chorionic gonadotrophin plus pituitary gonadotrophin is more active. The effects of crystalline products of the gonadotrophic substances were considered.

Dr. Collip mentioned that the estrins as a whole cause enlargement of the pituitary gland, as well as inhibition of function. A comparison of the side effects of the gonadotrophins was considered.

Oren Moore, Charlotte, N. C.: **Surgery of the Cervix in Sterility.**—The author spoke of the diseased cervix in relation to sterility. In his practice chronic endocervicitis is the etiological factor in the larger majority of sterile women. He described methods of classification of pathologic cervical canal with thick mucous plug. Medical treatment is considered useless. Electrical conization is often not effective and sometimes hazardous. Sturmdorf's type of coning is, in the belief of the operator, more scientific and highly successful.

Q. U. Newell, St. Louis, Mo., discussed results of various types of cervical treatment. J. M. Proctor, Raleigh, N. C., considered various ideas regarding treatment of the cervix. Howard Francis Kane, Washington, D. C., spoke of cauterization of the cervix. Frederick H. Falls, Chicago, Ill., considered pathologic phases of the cervix requiring treatment in sterility. Bender Z. Cashman, Pittsburgh, Pa., stressed the factor of endocervicitis. Robert A. Ross, Durham, N. C., Roland S. Cron, Milwaukee, Wis., Luman A. Gray, Louisville, Ky., and David Nye Barrows, New York City, contributed to the discussion by consideration of various phases of pathology and treatment of the cervix in sterility.

John G. Walsh, Providence, R. I.: **Stereoroentgenography of 400 Pelves With Clinical Correlation.**—Four hundred cases selected because of suspected or proved dystocia were studied by the stereoroentgenographic technique of Caldwell and Moloy and classified as gynecoid, android, anthropoid, or platypelloid. A clinical correlation was made. The android pelvis proved to be the most serious. Labor was prolonged and difficult although serious dystocia was encountered in all types of pelves. The method was of great benefit where operative intervention was necessary. The prognostic significance of the method was considered debatable.

Robert L. DeNormandie, Boston, Mass., gave a general discussion on clinical pelvimetry and its value, especially from a prognostic standpoint. J. Bay Jacobs, Washington, D. C., stated that where one wished to do roentgenographic pelvimetry one should select a suitable technique and follow it. He outlined various techniques in use. George F. Pendleton, Kansas City, Mo., suggested the use of x-ray pelvimetry at the time of labor. Frederick H. Falls, Chicago, Ill., advised that x-ray studies should be made of the pelvis at the time of labor. Wm. T. McConnell, Louisville, Ky., expressed the opinion that the obstetrician should be familiar with the x-ray technique of pelvimetry if he uses x-ray pelvimetry. LeRoy A. Calkins, Kansas City, Mo., suggested the importance of the position of the patient when x-ray pelvimetry is used, in cases of inlet and outlet dystocia.

Louis E. Phaneuf, Boston, Mass.: Inversion of the Uterus—Report of Five Personal Cases.—Dr. Phaneuf stated the predisposing factors in the etiology of inversion of the uterus are uterine inertia, pressure on the fundus from above, and traction on the cord from below. In the cases presented, shock was the leading symptom. The author stated, when shock is the leading symptom after the third stage of labor, inversion should be suspected. In acute cases the uterus should be reinverted manually when the condition is discovered. If this is not possible, a laparotomy and reposition by taxis are advisable. In chronic inversion, anterior colpohysterotomy, the Spinelli operation, should be performed when the uterus can be saved, and vaginal hysterectomy when it cannot. Abdominal hysterectomy may be performed when previous attempts at reduction have been made and the vagina is so bruised and ecchymotic that it is impossible to operate through it. Shock and hemorrhage should be combated by blood transfusions before and after operating. Five cases of puerperal inversion were reported.

M. Pierce Rucker, Richmond, Va., discussed the frequency of inversion now. He believes the etiology is questionable. The condition is difficult to produce deliberately by methods ascribed as the cause. Moreover, the symptoms may be late coming on, and the condition may be recognized late. **Samuel A. Cosgrove, Jersey City, N. J.,** stressed the point that the condition occurs mostly in multiparas in the cases reported. **James W. Kennedy, Philadelphia, Pa.,** cited his experience in five cases of inversion of the uterus with hemorrhage and chronic inflammation and infection. Three of these were old multiparas and were treated by hysterectomy. Two cases were operated upon early. **Irving W. Potter, Buffalo, N. Y.,** stated in his experience he had had no cases of inversion of the uterus. He feels that with the short second stage of labor by version and extraction the condition may be eliminated. **Wm. H. Vogt, St. Louis, Mo.,** outlined a case with repetition of inversion of the uterus after a Spinelli operation. **James E. Davis, Ann Arbor, Mich.,** discussed the possibility of high attachment of the placenta, as in the fundus, as a factor. **David N. Barrows, New York, N. Y.,** considered outcome of cases. **Frederick H. Falls, Chicago, Ill.,** presented the possibility of thickening of the fundus and thinning of the wall of the uterus as in arcuate uterus. **R. L. DeNormandie, Boston, Mass.,** outlined three cases of inversion of the uterus in his experience. Two he replaced. The other was treated by abdominal operation and taxis. **James K. Quigley, Rochester, N. Y.,** recounted results with the Aveling repositor. He cited the results of Victor Bonney. He reported the incidence at Rochester.

James E. King, Buffalo, N. Y., president of the Association, delivered the President's Address. This paper was not abstracted and should be read in its entirety in the *American Journal of Obstetrics and Gynecology* or the *Transactions of the Association*.

A. R. Abarbanel, Bronx, N. Y.: The Therapeutic Rationale for the Use of Testosterone Propionate in the Immediate Treatment of Functional Uterine Bleeding (Thesis—Awarded the Foundation Prize).—In this paper the author presented cases of bleeding that were treated by testosterone propionate. He outlined factors in the bleeding and the methods of administration of testosterone propionate. In his series a good outline of dosage was given.

H. M. N. Wynne, Minneapolis, Minn.: Struma Ovarii.—Dr. Wynne considered the frequency of the occurrence of thyroid tissue in ovarian dermoids and teratomas and pointed out how infrequent it is for an ovarian tumor to be com-

posed entirely of thyroid. He reported a case of solid ovarian tumor consisting of thyroid tissue only and with this tumor, a metastasis to the ischium. Lantern slides of various portions of the tumor, and of the x-ray studies of the ischium were shown.

James E. Davis, Ann Arbor, Mich., in discussing this paper, considered the frequency of teratomas or teratoblastomas and discussed theories of their development with frequency, occurrence, and pathologic characteristics.

Herbert Schmitz, Chicago, Ill.: *Hermaphroditism*.—Dr. Schmitz considered the proper classification of hermaphrodites. Regardless of appearance of genitals and secondary sex characteristics, he considers it important to determine whether testicles or ovaries are present. He then reported cases with comments on the findings and classification of the cases. The cases were demonstrated by lantern slides.

Wendell Long, Oklahoma City, Okla., reviewed the criteria of classification. He stressed the importance of consideration of the social attitude and sexual leaning of cases to be classified. He considered secondary sex characteristics of minor importance in classification of the individual. In the discussion Dr. Long reported a case studied.

James E. Davis, Ann Arbor, Mich., discussed the pathologic aspects in general. In the classification it is a matter of measurement of degree of potentialities.

Wm. Seaman Bainbridge, New York City: *The Interrelationship of Surgical Conditions of the Pelvic and Abdominal Viscera—Illustrative Cases*.—The author presented the viewpoint that the surgeon who enters the pelvic cavity must be prepared to cope also with pathological conditions in the abdominal cavity, and vice versa. He presented a number of cases with lantern slides, showing conditions where it would have been disastrous to leave the conditions present in both cavities, without adequate surgery.

James W. Kennedy, Philadelphia, Pa., discussed the presence of associated lesions in pelvic surgery. William Wayne Babcock, Philadelphia, Pa., recounted similar instances of inter-related pelvic and abdominal conditions requiring surgery. Walter T. Dannreuther, New York, N. Y., considered the matter of degree of extent of operative work important in determining how much to do at one operation. James E. Davis, Ann Arbor, Mich., discussed the frequency of operations and necessity of operative work. Tissues most frequently removed are tonsils, appendix, and ovaries. Many are perhaps too freely removed. In his experience only about one out of ten cases that go to autopsy following operation are seen by the surgeon who operated upon them.

Robert D. Mussey, Rochester, Minn.: *Report of an Investigation of the Clinical Relationship of Pyelitis of Pregnancy to Pre-Eclamptic Toxemia*.—Dr. Mussey's study included the symptoms and findings of 125 cases of pyelitis of pregnancy and 200 cases of pre-eclamptic toxemia reviewed. He feels that the data from these cases show that even though acute pyelitis is not an infrequent complication of pregnancy, it is uncommon for it to be associated with manifestations of pre-eclamptic toxemia or the late toxemia of pregnancy. The paper was illustrated with lantern slides.

R. T. La Vake, Minneapolis, Minn., outlined his experiences with the conditions in question. He pointed out the importance of frequency of the two conditions,

from Dr. Mussey's figures. He also discussed the relation between toxemia and infarction of the placenta. He stressed the high probability of complete recovery. Dr. La Vake feels that the paper helps maintain our balance between pyelitis and toxemia. Herman W. Johnson, Houston, Tex., considered the cases of pyelitis associated with bleeding from the uterus. As a possible cause he considered the theory of back pressure of veins of intervillous spaces plus the effect of bacterial enzyme. He feels that one can associate pyelonephritis and toxemia.

W. T. McConnell and Luman A. Gray, Louisville, Ky.: Studies of the Female Ureter After Delivery.—In this work Dr. McConnell and Dr. Gray studied a series of cases with normal delivery and normal post-partum course, to determine the return of ureterectasis and pyelectasis to normal. This they considered along with the work reported by other investigators in the literature. In the second part of their study they followed the cases with puerperal pyelitis. Intravenous pyelograms were studied several years after the puerperal pyelitis. This study was intended to give some indication of the outlook from the urinary tract point of view for the patients with pyelitis during the puerperium. This paper was accompanied by lantern slides of tables and of pyelograms of patients at various periods of pregnancy, puerperium, and later.

Robert A. Ross, Durham, N. C., discussing the paper, stated that attention should be paid to urinary tract conditions after pelvic operative procedures. He feels that there are many cases of dilatation without symptoms. In reviewing the work in hospital practice he called attention to the fact that 60 per cent of pyelitis cases occurred in 25 per cent of the patients on the private service. **Buford G. Hamilton, Kansas City, Mo.,** raised the question of cause of dilatation, the result of increased muscular activity of the ureters to express increased amount of urine in pregnancy. He suggested the anatomical type of patient as having to do with the frequency of urinary tract dilatation. **H. M. N. Wynne, Minneapolis, Minn.,** considered the condition of urinary tract before pregnancy takes place as being a factor in pyelitis of pregnancy and dilatation of the urinary tract. **Frederick H. Falls, Chicago, Ill.,** enumerated certain points in reference to the behavior of the urinary tract, including physiologic changes in the lower end of the ureter due to pressure and enlargement of the uterus, and the fact that the urinary tract and uterus develop from the same embryologic anlage. A possible cause of pregnancy pyelitis is that the urinary peristalsis is slower in both sides. It is probable this effect is hormonal in origin. Again, there may be some pathology already present in the ureters of patients who develop pyelitis.

Dr. Gray suggested that the next studies made on the behavior of the urinary tract in relation to pregnancy be along the line of hormone effect, probably progesterone. He feels that cases having had pyelitis should be followed with treatment during the puerperium.

Joseph W. O'Connor, Worcester, Mass.: Spontaneous Rupture of the Uterus.—According to the observations of the author, rupture of the uterus is one of the most deadly accidents of pregnancy. There are two types of rupture, complete and incomplete. The latter is rare. Spontaneous rupture is more common than traumatic rupture. The incidence cannot be accurately estimated since many cases are unrecognized. It is highest at the end of pregnancy and in labor. Rupture of the scar of previous classical cesarean section provides most of the reported cases. Relatively few follow cervical section. The causative factors may be classified in general as mechanical and histologic. The treatment is strictly surgical.

Howard F. Kane, Washington, D. C., studied cases reported some time ago. It seemed from these reported cases multiparity and invasion of the uterus were the two most common factors. The cases of rupture with ruptured scar and rupture after pituitary were hardest to diagnose. In the cases the degree of shock was greater than the degree of hemorrhage. One case was reported with a placenta accreta. Ward F. Seeley, Detroit, Mich., reported his varied experience with rupture. In two Detroit hospitals he found twenty-four cases of ruptured uterus. He outlined incidence and causes. He advised more transverse cervical cesarean sections. He advocated frequent transfusions in treatment. H. C. McDowell, Buffalo, N. Y., quoted observations on uterine rupture. The incidence after section about 1.5 per cent. Dr. McDowell believes incidence after low type of section greater than with high incision. Louis E. Phaneuf, Boston, Mass., quoted figures to show frequency of rupture after cesarean scar—after classical section, 4.1 per cent; after cervical section, 1.3 per cent. He also mentioned the condition of forty-four healed scars.

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The following motion pictures were shown: *Abdominoperineal Proctosigmoidectomy*, by W. Wayne Babcock, M.D., Philadelphia, Pa.; *The Treatment of Prolapse by Vaginal Hysterectomy*, by Archibald D. Campbell, M.D., Montreal, Quebec; *Forceps Deliveries Illustrating the Use of Special Types of Instruments*, by Edward H. Dennen, M.D., New York, N. Y.; and *Kielland Forceps Operations—Episiotomy—Repair With Knotless Sutures*, by M. Pierce Rucker, M.D., Richmond, Va.

Book Reviews

Cancer Laringeo, sur tratamiento quirurgico. By Ricardo H. Bisi. Paper. Pp. 355, with 101 illustrations. Buenos Aires, 1938, Libreria y Editorial, "El Alceo."

This 355-page monograph, comprising twenty-eight chapters, is concerned primarily with the surgical aspects of carcinoma of the larynx.

The first chapter consists of an interesting historical résumé of the surgical progress in the cure of laryngeal cancer. A succinct consideration of the frequency of these malignant tumors and their incidence according to sex and age as well as a discussion of the predisposing causes is presented. The pathologic anatomy, the classification of tumors into histologic groups, and the method of spread are discussed in detail. The various procedures which may be employed for diagnostic purposes are satisfactorily considered. The author then presents the pathologic and clinical characteristics of the various types of tumors depending upon their location.

A thorough discussion of the advantages and disadvantages and the indications and contraindications of the different types of operative procedures are given. The preoperative and postoperative treatment is considered as well as the complications and the plastic procedures which may be employed in the repair of defects following extensive resections. The author's conclusions are summarized in French, English, and German.

The book is written in a clear, concise, and pleasant style and the author's opinions are rationally expressed. The numerous illustrations are apt, instructive, and well reproduced. However, the inclusion of a bibliography undoubtedly would have enhanced the value of the monograph.

Surgery of the Eye. By Meyer Wiener, M.D., and Bennett Y. Alvis, M.D. Cloth. Pp. 445, with 396 illustrations. Philadelphia, 1939, W. B. Saunders Company. \$8.50.

In the preface to this scholarly volume the authors state that they had two purposes in mind. The first was to supply a handy atlas that the practicing ophthalmologists and students of ophthalmology can quickly refer to for information on surgical correction of ocular defects and disease. The second was to illustrate clearly each detail of the operations selected, thereby correcting a fault found in many surgical texts, where too much is left to the description text. A careful study of the book impresses one with the fact that they have accomplished their purpose and produced a thoroughly practical book.

The appreciation of the volume is greatly enhanced because it represents the summary of an extensive surgical experience of outstanding ophthalmologists and teachers. Those who have had the privilege of studying under the authors will more fully appreciate the book, because they are familiar with the fact that the authors are not only able teachers but are practical and original in their approach to surgical problems. In presenting the work, only methods have been selected for consideration which serve best the purpose in a given surgical condi-

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SURGERY

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ACUTE TRAUMATIC DISLOCATION OF THE TENDON OF THE LONG HEAD OF THE BICEPS BRACHII

A REPORT OF SIX CASES WITH OPERATIVE FINDINGS

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SAN FRANCISCO, CALIF.

(From the Department of Orthopaedic Surgery, Division of Surgery, and the
Division of Anatomy, University of California Medical School)

TRAUMATIC dislocation of the tendon of the long head of the biceps brachii has always been regarded as a lesion of infrequent occurrence. Codman, for example, in his excellent book, *The Shoulder*, lists it under the rare lesions of the shoulder joint.

Our interest in this condition was awakened in 1932 by the first case herein reported and in which our diagnosis was later confirmed by operation. Shortly thereafter, three additional cases were observed and these four cases were embodied in a report made by us at the meeting of the American Orthopaedic Association in June, 1934.* At that time we were unable to discover any case recorded in medical literature in which the diagnosis was afterwards proved by operation. In discussing this report, Gallie and Speed both stated that they had operated upon similar cases. More recently we have had two additional cases which we are including in this report. From this experience we believe that the lesion is not as rare as was formerly supposed and is a condition which should always be borne in mind in the diagnosis of disabilities affecting the shoulder joint.

LITERATURE

The first reported case of dislocation of the tendon of the long head of the biceps brachii muscle appears to have been in a work published in 1694 by William Cowper, entitled *Myotomia Reformata*. He related

*Read at the Forty-Eighth Annual Meeting of the American Orthopaedic Association in Rochester, Minn., June 8, 1934.

Received for publication, June 6, 1939.

tion, and which have proved of value in their personal experience. Throughout the text are many hitherto unpublished suggestions and methods.

The task of classification and arrangement was solved by the authors with skill and judgment.

The book is divided into eighteen chapters and consists of 445 pages, including the index, and 396 illustrations. The quality of the binding and print is excellent. The illustrations are well executed, being done by an artist-physician.

The first five chapters deal with more general subjects, such as general considerations, pre- and postoperative care, and anesthesia. Chapters 6 to 13 deal with conditions related to the eyeball; whereas, Chapters 13 through 18 deal with conditions related to the lids, socket, conjunctiva, muscles, and lacrimal apparatus.

In the first five chapters which comprise 50 pages, the subjects are covered briefly, but to the point. The chapter on the newer methods of local anesthesia is especially noteworthy. Great thoroughness marks Chapter 7 dealing with cataract surgery. It consists of 48 pages and is splendidly presented. Chapter 8 on glaucoma is also outstanding.

Perhaps the most valuable contribution was made in Chapters 14 and 15 in dealing with the lids and socket, a very difficult field. The subject is clearly presented, the methods worthy of note. In Chapter 18 their discussion of the Wiener-Sauer technique for dacryocystorhinostomy is especially valuable.

Although the book cannot be considered a complete presentation of surgical problems related to the eye, it is an excellent reference book and text of definite value to not only the beginners, but also the experienced in this very intricate branch of surgery. No ophthalmic surgeon can afford to be without this book.

Sclerosing Therapy: The Treatment of Varicose Veins, Hemorrhoids, Hernia and Hydrocele by Injection. Edited by Frank C. Yeomans, M.D. Cloth. Pp. 337, with 185 illustrations. Baltimore, 1939, Williams and Wilkins Company. \$6.

The interest in sclerosing therapy has become so widespread that a review of the present-day knowledge of this subject is most welcome.

Dr. A. F. Bratrud writes concerning the injection treatment of hernia. His broad experience and interest in this subject are well known. The reviews of the anatomy of hernias, the fitting of trusses, and technique of injection are excellent. However, the clinical results following injection therapy and the histopathology of such injections in animals would be more impressive if a longer period (five years) had elapsed before the results were studied. The chief objection against injection treatment of hernia according to some observers is the impression that the fibrous tissue tends to disappear and the hernia recurs after a number of years. An impartial investigation of these matters must be undertaken before the value of this form of therapy is firmly established.

The treatment of hydrocele is reviewed by Dr. George Hoch. The technique of injection is clearly stated. Under differential diagnosis, spermatocele should be mentioned as a diagnostic possibility.

The chapters on the sclerosing therapy of varicose veins and internal hemorrhoids by Dr. H. J. Shelley and Dr. Yeomans respectively are well done.

This book is a practical and clear exposition of the present status of injection therapy. There are few books with better descriptions of technique. For all interested in the subject of sclerosing therapy, this book is strongly recommended.

usual movements. The long tendon of the biceps may be dislocated outward or inward by movements which combine forcible flexion of the forearm with rotation at the shoulder as in wringing clothes. The displacement prevents extension of the forearm until the tendon is replaced by abduction or adduction as the case may be. The tendency to displacement may become habitual." The inaccuracies of this statement are obvious and we seem to hear Cowper's case echoing down through 250 years—the wringing of clothes.

More recently in 1926 and 1928 valuable contributions to our knowledge of this subject were published by Meyer. In his later publication Meyer discusses his observations based on a total of thirty-nine instances of spontaneous dislocation of the long tendon of the biceps brachii and on twenty examples of total destruction of the capsular portion of this tendon. These studies carried out on dissecting-room material were a continuation of a series published in the years 1913, 1915, 1921, 1922, and 1924 on destruction of tendons and joints "from use."

In only six of the thirty-nine cases was the dislocation maximal; that is, the long head had passed completely over the lesser tuberosity, the remaining cases representing transitional stages. The subjects were of both sexes, the majority Caucasian, and all presumably belonged to the laboring classes. The ages ranged from 50 to 80 years and because of the nature of the material clinical histories were totally lacking.

Meyer concludes that attrition, particularly following the use of the extremity in abduction and lateral rotation, leads to a gradual stretching, detachment, or destruction of the capsule proximal to and in the region of the lesser tuberosity. As a consequence of the weakening of the capsule, which he considered to be the chief restraint to displacement, dislocation ensued. He employs the term "spontaneous" to convey the idea that external trauma, accident, or disease is not necessarily involved in these cases. In an earlier paper he states in this connection: "It is doubtful whether severe or sudden strain, even if prolonged or repeated, can produce the dislocation. . . . Probably strenuous and long continued use resulting in capsular defects alone can produce the condition necessary for its occurrence."

APPLIED ANATOMY

The general position of the long head of the biceps, from its origin at the supraglenoid tubercle and labrum glenoidale to its course through the intertubercular (bicipital) sulcus, is so well known as scarcely to warrant description here (Fig. 1). There are, however, some details of anatomy and of function which it seems desirable to discuss.

Traditional teaching has it that the tendon is held in place within the sulcus by means of the transverse humeral ligament, a statement which is somewhat misleading. The relative unimportance of the transverse humeral ligament is fully recognized by Meyer, who says that he has

the case of a woman who, while wringing clothes, felt something displace itself at the shoulder. On examination three days afterwards, he noticed a depression of the external part of the deltoid, accompanied by rigidity in the lower part of the biceps and inability to extend the forearm. The following day he manipulated the arm in various directions, whereupon the supposedly dislocated tendon slipped into place and the patient at once recovered the use of the arm. In the following century Cowper's case reappeared in the literature, both with and without recognition of its origin, and the possibility of this lesion was accepted by such influential teachers as Boerhaave and Bromfield. But Cowper's observation became subject to suspicion in the minds of several authors in the next two centuries because of the notoriety which he gained by the publication of his later work on anatomy. The plates of this famous elephant folio were appropriated from Godfried Bidloo, the Dutch anatomist, a not uncommon practice in those days, but the plagiarism was judged of little moment by Boerhaave on account of the slender value of Bidloo's text.

A century later, in 1803, Monteggia reported a second case resembling somewhat in its clinical features that of Cowper except for the dislocation's being habitual, and from that time on until 1910 numerous additional clinical records and articles appeared at intervals. Some of these were highly disputatious; among them may be mentioned those by Jarjavey, Soden, Green, Gerster, White, Marsh, Robinson, Habernern, and Parkhill.

The subject became one of considerable controversy, many frankly denying the possibility of such a lesion. The role played by the long head of the biceps in the so-called partial dislocation of the humerus (Astley Cooper), the effect of arthritis (Adams), and the question of a subacromial bursitis (Jarjavey) figure prominently in the criticisms offered by Bardeleben, Volkmann, Pouteau, von Pitha, Malgaigne, and Chassignac. Soden's case, reported in 1841, is important and unique in that it is the only clinical case which was proved by necropsy, although several examples had been described in which a dislocation was found in dissection material, notably by Stanley.

In 1884, White published a comprehensive review of the literature and, after concluding that cases previously reported "fail altogether to carry conviction," included a clinical report of some length on a case which he had personally observed. The obvious errors and misconceptions presented by White in this analysis have been ably pointed out by Meyer.

Since the time of White's report, the subject of dislocation has been kept alive and renewed mainly by the various anatomical and surgical texts, rather than by practical experience. The recent text by Homans contains no more than the statements: "Several important tendons which run in bony grooves are occasionally dislocated by violent and un-

than Meyer's comments would lead one to believe. The most important feature in retention of the tendon is that portion of the capsule of the shoulder joint which bridges the tubercles in the uppermost part of the sulcus. In this region, the capsule is thick and strong and is reinforced by the blending of the neighboring tendons and fasciae. This portion of the capsule is the first and chief obstacle to forward dislocation of the tendon and Meyer found that in all of his cases it had been torn or stretched. Codman, in commenting on Meyer's work, states that, in his opinion, displacement of the tendon is the result of rupture of that portion of the musculotendinous cuff which is inserted into the inner side of the intertubercular notch. This portion is made up of the joint edges of the supraspinatus and subscapularis tendons. (Figs. 2 and 3.)

Occasionally other anatomical features in the construction of the sulcus may exist, such as the presence of or absence of a supratubercular ridge and the varying depth of the sulcus. The supratubercular ridge is described by Meyer as a ridge which extends forward and downward from the region of the articular cartilage to the upper and dorsal portions of the lesser tuberosity. Quoting Cilley, he states that it occurred in 17.5 per cent of 200 humeri. This ridge, when present, must play an important role in dislocation as its distal extremity is on a level with the lesser tubercle and therefore it mechanically diminishes the effectiveness of the tubercle as a trochlea. The depth of the sulcus is an extremely variable factor, depending upon the degree of development of the tubercle and the lips of the sulcus (Fig. 2).

The anatomical factors which favor dislocation of the tendon are well summarized by Meyer: "In all normal joints there are three, and there may be six factors which favor dislocation of this tendon: (1) the normal course of the intracapsular portion of the tendon and its relation to the humeral head, (2) the much greater width of the proximal portion of the tendon, (3) the fact that the anterior wall of the sulcus which is formed by the lesser tuberosity normally acts as a trochlea for the tendon in the usual position of medial rotation, (4) a supratubercular ridge may be present, (5) the capsular attachment may be weakened by intracapsular bursae, and (6) the capsular attachment to the anatomic neck in the region proximal to the lesser tuberosity may be restricted."

The relation of the tendon to its groove varies considerably with different positions of the arm. In medial rotation the tendon is applied to the lateral wall of the sulcus and the adjacent capsule. In slight lateral rotation it occupies the floor of the sulcus. In these positions, therefore, there is no tendency for dislocation to occur. As lateral rotation is increased, the tendon is forced against the medial wall of the sulcus, especially that part formed by the lesser tubercle and the capsular attachment proximal to it. It is of some importance in the mechanism of dislocation to note the changes in angulation of the tendon with varying degrees of abduction or flexion. With the arm at the side, the angula-

found "this structure either too weak or entirely absent and that transverse fibers bridging the sulcus, which could be properly described as a ligament, seldom are present, and when this is the case, they are found lower down than the so-called ligament of Brodie is supposed to occur." In our opinion the chief structure retaining the tendon within that part of the sulcus which lies below the level of the summits of the greater

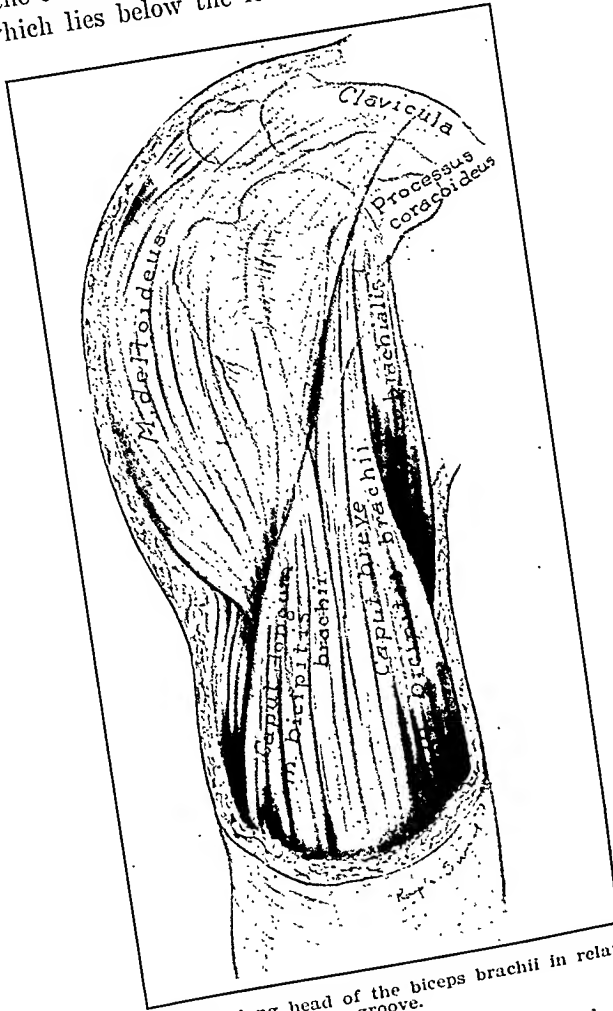


Fig. 1.—The tendon of the long head of the biceps brachii in relation to the bicipital groove.

and lesser tubercles is a tendinous expansion from the insertion of the sternocostal portion of the pectoralis major muscle. This expansion, which forms a falciform margin at the deep aspect of the main tendon, is attached to both lips of the sulcus and blends above with the capsule of the shoulder joint. As a rule a few, relatively weak, transverse fibers strengthen the roof so formed. We have often observed, at operation, that the retinaculum so formed is, however, somewhat more substantial

angulation increases, the tendon is thrown more and more against the lesser tubercle, which then acts as a trochlea. It is in these, the lesser ranges of movement, that the tendon depends for its security in greater measure on the lesser tubercle and the fibrous, anterior roof of the sulcus. At 45 degrees or less of abduction or flexion, the tendon can be most readily displaced from its groove by lateral rotation.

FUNCTION OF THE LONG HEAD OF THE BICEPS BRACHII MUSCLE

Analysis of the action of the component muscles participating in the production of motion at the shoulder joint is notoriously difficult and there is great conflict of opinion, notably in regard to details of action of the individual muscles. There can be no question that much of this conflict arises from failure to appreciate the correct sequence of motion as it occurs in elevation of this extremity.

The common teaching has it that, when the arm is raised, movement up to the right angle occurs at the scapulohumeral joint and that, thereafter, further elevation of the limb is brought about by rotation of the scapula. This teaching, patently incorrect, is nevertheless of wide acceptance both by anatomists and clinicians. Any analysis of the action of muscles about the shoulder based upon the assumption that the above teaching is correct or upon the assumption that the scapula is fixed, as in the recently published experiments of Howard and Eloesser, is bound to lead to erroneous inferences in many important details. For example, we find Howard and Eloesser reaching the remarkable conclusion that the subscapularis muscle acts as an abductor beyond 45 degrees of abduction. Such a finding is not surprising under the conditions of their experiments. When the scapula is fixed, as in their "phantom" model, and the humerus abducted beyond 45 degrees, the insertion of the subscapularis muscle is carried above the axis of movement and the muscle necessarily becomes an abductor. In the living subject, however, it is predominantly scapular rotation which carries the arm to the right angle and true scapulohumeral rotation occurs, for the most part, only above this level. For this reason, it is extremely doubtful that the moment of action of the subscapularis muscle ever rises above the fulcrum at the shoulder joint, even when the arm is carried to 180 degrees, and therefore dubious that, under functional conditions, this muscle ever acts as an abductor of the arm. Furthermore, as pointed out by Lockhart, it is impossible to abduct the arm of the living subject beyond 15 degrees if the scapula has been fixed. For such reasons we find to be unacceptable any opinions on muscle action at the shoulder which neglect the normal sequence of movement. Therefore, an essential preliminary to a discussion of the function of the long head of the biceps is the mention of some of the features which characterize motion at this joint.

The shoulder joint itself, that is the scapulohumeral joint proper, when in motion simply plays a part in a complex arrangement of sev-

tion of the tendon, as it lies in the uppermost part of the groove, approaches a right angle. As abduction is increased, the angulation progressively disappears until at and above 90 degrees of abduction the tendon pursues an almost straight path from its origin at the supraglenoid tubercle to its muscular belly. In consequence, as may be ob-

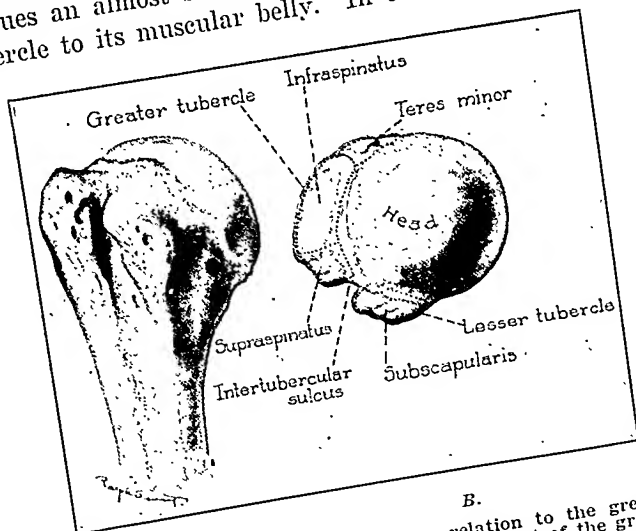


Fig. 2.—A, Contour of the bicipital groove in relation to the greater and lesser tuberosities of the humerus. In this specimen the upper part of the groove is unusually deep. B, Relation of the bicipital groove to the insertion of the tendons of the supraspinatus and the subscapularis.

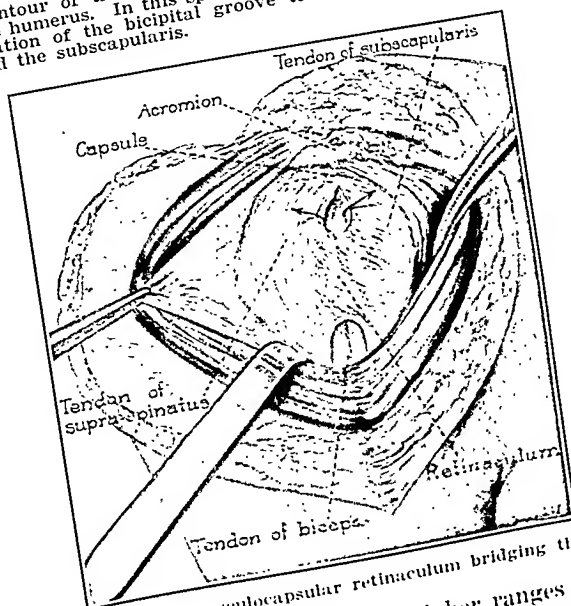


Fig. 3.—Shows the strong, musculocapsular retinaculum bridging the bicipital groove. served upon examination, there is in the higher ranges of abduction or flexion little tendency for the tendon to slip from its groove. In these positions the tendon, being more nearly straight, parallels the axis of rotation. On the other hand, as the arm approaches the side and the

author has shown by an examination of the phylogeny, anatomy, innervation, and also by clinical illustrations that the muscle which arrests and changes the direction of the deltoid, is the *teres minor*. This muscle steadies the humeral head in the glenoid and renders the action smoother. In forward flexion the mass of the pectoral musculature is thrown into action which tends to displace the head of the humerus, a tendency which cannot be altogether overcome by the action of the *teres minor* and *major* muscles. It is here, we feel, that the long head of the biceps muscle plays its chief role. This tendon, from its course and direction, serves mechanically to guide and redirect the humeral head in its backward and downward path so that action as a whole is gracefully synchronized.

That this is the function of the long head of the biceps is borne out by clinical observations. Rupture or operative severance of the long head of the biceps is seldom attended with any functional loss of great consequence. We have always observed, however, that in these cases there is a loss of strength and rhythm which is most evident in forward flexion and especially in movements above the right angle. Undue prominence of the humeral head anteriorly is noticeable in cases of rupture or dislocation of the tendon or after the Nicola operation. This is apparent in some of the clinical histories given below and was very noticeable in the subsequent history of Case 1. The necessity of the direct attachment of the biceps to the scapula in order to restrain the head of the humerus was appreciated by Duchenne, who states: "Here are clinical facts which show the utility and also the necessity for the direct attachments of the biceps brachii to the scapula. Subjects in whom I have discovered the biceps brachii atrophied were still able to flex the forearm strongly with assistance of the *brachialis anticus* and the *brachioradialis* but, at that time, if resistance to flexion of the forearm was great, as in raising a heavy weight from the ground, by flexing the forearm on the arm, the head of the humerus was displaced from the glenoid cavity and the subject would experience, in the articulation of the scapulohumeral joint, a pulling sensation which became painful if the weight was too heavy or if the movement was too prolonged or too frequent. For the workman this was a cause of weakness or deficiency and he was unable to carry on laborious work for a long time without suffering. This fact demonstrates, therefore, that it is necessary that one of the muscles which produces flexion should, at the same time, maintain the head of the humerus against the glenoid cavity of the scapula. These conditions find themselves perfectly supplied by the long portion of the biceps brachii." In addition, there is no doubt that the long head of the biceps is a mild, medial rotator when the arm is in lateral rotation and at the side of the body.

The action of the long head of the biceps at the humerus must be regarded as both active and passive. "It is," says Codman, "the upper

eral joints. Careful inspection and palpation of the living subject, especially when combined with fluoroscopic examination, reveal some of the details of the sequence of motion which occur in raising the arm from the side. These methods show that, in motion, the clavicular, scapular, and humeral joints all participate from the very commencement to the termination of the act in a continuous and harmonious movement.

Briefly, the sequence of motion is that at the very inception of the act of raising the arm, the scapula commences to move outward. By the time the arm is at right angles to the trunk, scapular rotation is almost complete, while at the same time but little motion has occurred at the shoulder joint. Our measurements demonstrate that approximately only one-sixth of the available range at the shoulder joint occurs in movements up to the right angle. In carrying the arm above the head to the perpendicular, motion occurs mainly at the shoulder joint, accompanied, however, by further slight scapular rotation.

During the first 15 to 20 degrees of movement of the arm away from the side, our studies have convinced us that there is an initial upward movement of the head of the humerus on the glenoid. This initial movement of the humerus on the glenoid, almost imperceptible in the harmonious action of the normal joint, is revealed only by a comparison of radiograms taken under exact and standard conditions and is morphologically reflected in the elongated or pearlike shape of the glenoid cavity. Still more convincing evidence of the reality and extent of this movement of the humerus has been obtained on patients operated upon under local anesthesia in the sitting position. Under these conditions, the humerus has been observed to glide, at the initiation of abduction, upward on the tendon of the biceps for almost one-half inch. With further movement at the scapulohumeral joint, the head of the bone glides downward on the glenoid in abduction and both downward and backward in forward flexion. The validity of these conclusions is amply established by clinical experience. In the liberation of the stiff shoulder the establishment of a free pathway for the head of the humerus on the glenoid in an upward and downward direction is of primary importance, and in cases of paralysis we have been highly gratified by the results of re-education of this, the normal sequence. The prominence exhibited at the anteroinferior lip of the glenoid is a related structural arrangement. Recurrent dislocation of the shoulder joint is, as is well known, a common sequel to fracture of this lip or to tearing of the attachment of the related capsule. It is the anteroinferior part of the joint which, as abduction is increased, holds and prevents, to some extent, displacement of the humeral head.

Having discussed some of the details of motion at this joint, the next consideration is the function of the related muscles. "The primary movement which the deltoid imparts to the humerus," says Greig, "is not abduction but a drawing of the humerus directly upward." This

author has shown by an examination of the phylogeny, anatomy, innervation, and also by clinical illustrations that the muscle which arrests and changes the direction of the deltoid, is the *teres minor*. This muscle steadies the humeral head in the glenoid and renders the action smoother. In forward flexion the mass of the pectoral musculature is thrown into action which tends to displace the head of the humerus, a tendency which cannot be altogether overcome by the action of the *teres minor* and *major* muscles. It is here, we feel, that the long head of the biceps muscle plays its chief role. This tendon, from its course and direction, serves mechanically to guide and redirect the humeral head in its backward and downward path so that action as a whole is gracefully synchronized.

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end of the humerus, using the tendon and canal as a guide, which rides up and down in motions of the shoulder joint and not, as superficially thought, the long head of the biceps which plays in the groove when the forearm is moved."

The practical importance of these observations is apparent from a study of the following six cases in which operation proved the diagnosis.

CASE 1.—L. C., male, 37 years of age. *Chief Complaint:* Pain and weakness of the left shoulder. *Present Illness:* The patient sustained his injury on Aug. 2, 1932, while lifting three-hundred-pound blocks of ice. As he lifted one block, he felt a severe pain in the front of the left shoulder. Unable to continue his work, he consulted his physician who prescribed rest and heat. After a few days' treatment, he tried to return to work, but was unable to do so because he could not lift a weight of even sixty pounds. He had been doing heavy work continually for thirteen years prior to his accident.

We first saw the patient four weeks after the injury. He complained of a dull pain over the anterior aspect of his left shoulder which was aggravated by abduction and flexion.

Physical Examination.—The patient was a well-developed and muscular man. His left shoulder appeared slightly swollen and there was generalized tenderness over its anterior aspect. The most sensitive area lay directly over and just lateral to the coracoid process.

On physical examination active abduction at the shoulder was limited to 120 degrees; flexion was free to 180 degrees. Moderate abduction and lateral rotation were associated with pain and a "clicking" sensation could be elicited in the region of the coracoid process. Flexion of the elbow or flexion of the shoulder against resistance caused pain in the same area. All motions of the shoulder were weak, notably abduction and flexion.

The striking finding was that moderate abduction of the arm with external rotation produced a definite snap which could be felt over the anterior aspect of the joint. A dislocation of the tendon of the long head of the biceps was suspected and operation was advised.

Operation, Dec. 9, 1932.—An incision was made over the anterior aspect of the shoulder with separation of the deltoid and pectoralis major muscles. The long head of the biceps tendon was found to be dislocated over the lesser tuberosity of the humerus. The supraspinatus tendon was ruptured partially at the margin of its attachment to the anterior border of the greater tuberosity. With the arm abducted to about 70 degrees, rotations caused the tendon of the long head of the biceps to ride backward and forward over the lesser tuberosity. On external rotation it was dislocated to the medial side of the tubercle and on inward rotation it reduced itself with an audible snap. There was slight fraying of the tendon in its intracapsular portion together with a partial tear of the origin of the tendon of the long head of the biceps from the margin of the glenoid.

Repair consisted of deepening of the bicipital groove with replacement of the tendon and reconstruction of the roof. The supraspinatus tendon was sutured with chromic catgut. The shoulder was immobilized in abduction.

Subsequent Course.—The postoperative treatment consisted of baking, massage, and exercises. After ten months, flexion and supination of the forearm were free, strong, and painless, but marked weakness of abduction and forward flexion of the shoulder persisted.

Second Operation, Oct. 6, 1933.—Under local anesthesia the old scar was excised and the capsule of the joint and the bicipital groove were opened. The distal por-

tion of the long head of the biceps was found firmly attached to the floor of the bicipital groove and its proximal intracapsular portion had disappeared, except for a few fibrous strands which were adherent to the adjacent capsule. These strands were excised and the capsule was sutured.

The postoperative treatment consisted of baking and exercises. The patient exhibited some weakness of the shoulder, especially in abduction and forward flexion. With the elbow extended, he was unable to flex the arm forward at the shoulder against any considerable resistance. The function of the forearm in flexion and supination was excellent.

Examination on April 17, 1934, showed no further snapping on abduction and external rotation but otherwise showed a failure of any important improvement in his condition. The functional result in this case was entirely unsatisfactory because of the marked weakness at the shoulder in forward flexion and abduction. In all probability this was caused by lack of fixation of the humeral head as a result of the combined lesion of the supraspinatus and the tendon of the long head of the biceps.

The patient was re-examined on Dec. 21, 1938. He had weakness and pain in the shoulder on motion and in damp weather. He complained of a cracking sensation in the shoulder on abduction and of weakness when he attempted to lift a heavy weight.

Examination at this time showed abduction to be limited to 135 degrees; forward flexion to 170 degrees. Active abduction could be carried to 80 degrees. When the arm was in full abduction and flexion, a very definite snapping could be heard and felt and this snapping was associated with pain.

CASE 2.—F. G., male, 40 years of age. *Chief Complaint:* Pain and weakness of the right shoulder. *Present Illness:* On Nov. 28, 1932, while lifting a heavy piece of ice, he had a severe pain in the anterior aspect of the right shoulder which caused immediate disability. In one month's time all of the subjective symptoms had disappeared and the patient was placed on active exercises. Two days later he again complained of pain in the front of the shoulder with pain and weakness on forward flexion and abduction. Abduction and external rotation elicited a closed tenderness over the anterior aspect of the shoulder. Stereoscopic roentgenograms of the shoulder at this time disclosed no evidence of bony change or arthritis.

Physical Examination.—There was moderate, generalized atrophy of the muscles of the affected shoulder. Palpation revealed tenderness over the anterior aspect of the shoulder in the region of the bicipital groove. There was a distinct disturbance in the scapulohumeral rhythm on the right side. Abduction was initiated quite freely, but, when an angle of 50 degrees was reached, the shoulder hunched with pain before further abduction could be obtained. On several occasions, when moving his arm into active abduction, a marked snapping could be felt in the region of the bicipital groove. Active flexion and supination at the elbow against resistance caused pain referred to the same region.

Roentgenograms taken on March 6, with the shoulder in internal and external rotation, showed irregularity of the bone along the margin of the lesser tubercle of the right humerus. A diagnosis of dislocation of the long head of the biceps was made.

Operation, March 8, 1933.—An incision was made through the anterior portion of the deltoid muscle. The principal findings were dislocation of the tendon to the medial side of the lesser tubercle, partial tear of the adjacent attachment of the

subscapularis tendon, and a filling of the bicipital groove with scar tissue. The tendon was fixed to the floor of the bicipital groove. (Figs. 4-8.)

Subsequent Course.—The convalescence was uneventful and the patient was discharged from the hospital on March 29, 1933. On June 30, 1933, there was active

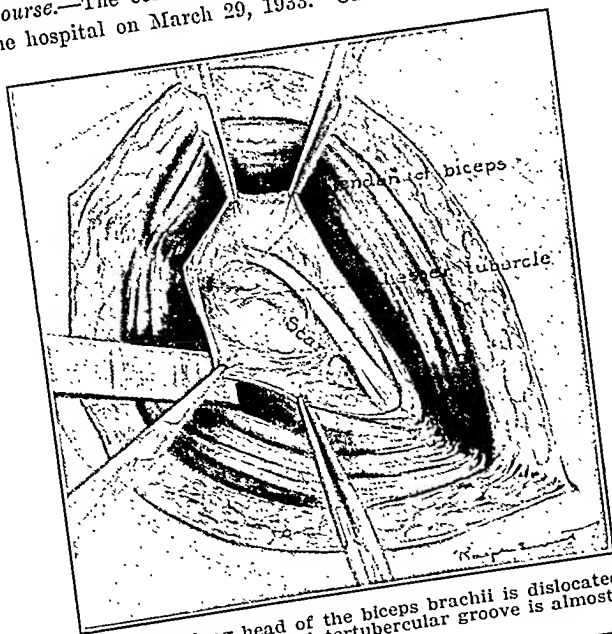


Fig. 4.—The tendon of the long head of the biceps brachii is dislocated over the lesser tuberosity of the humerus and the intertubercular groove is almost obliterated.

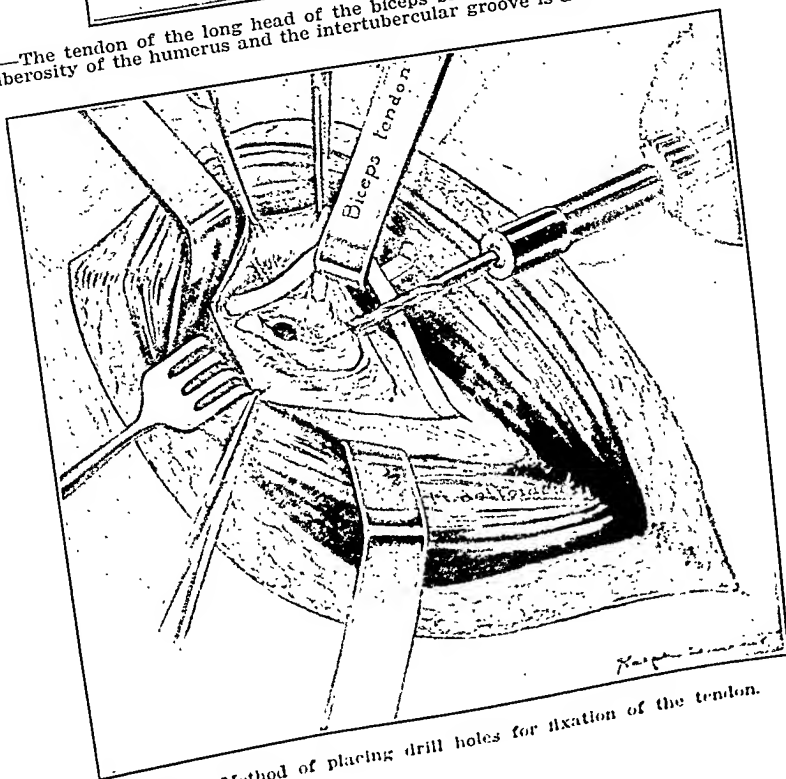


Fig. 5.—Method of placing drill holes for fixation of the tendon.

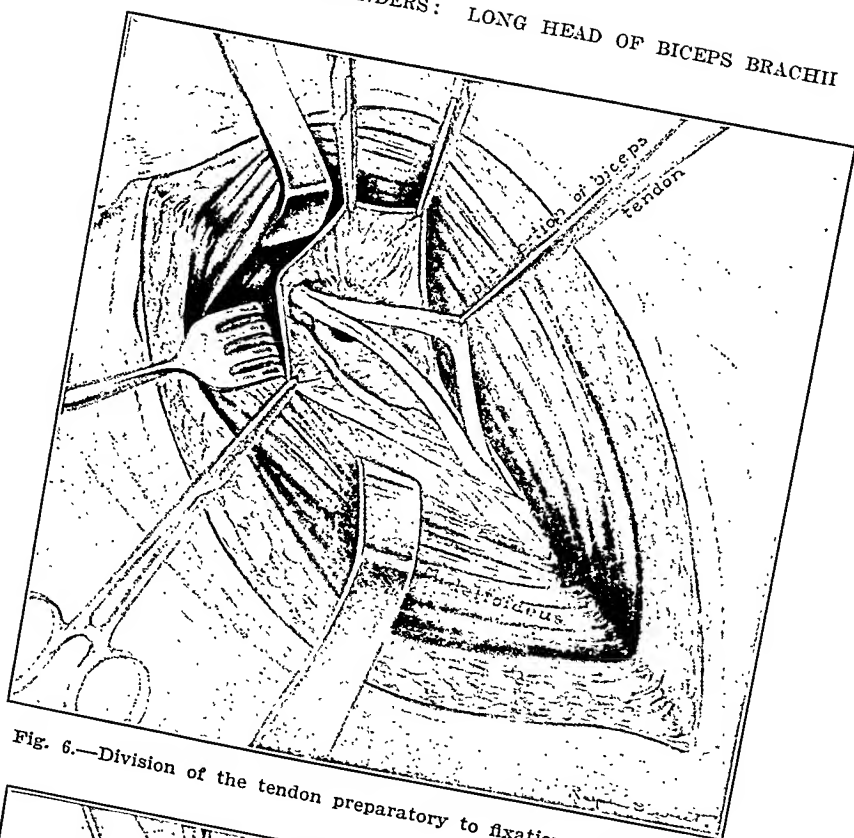


Fig. 6.—Division of the tendon preparatory to fixation in drill holes.

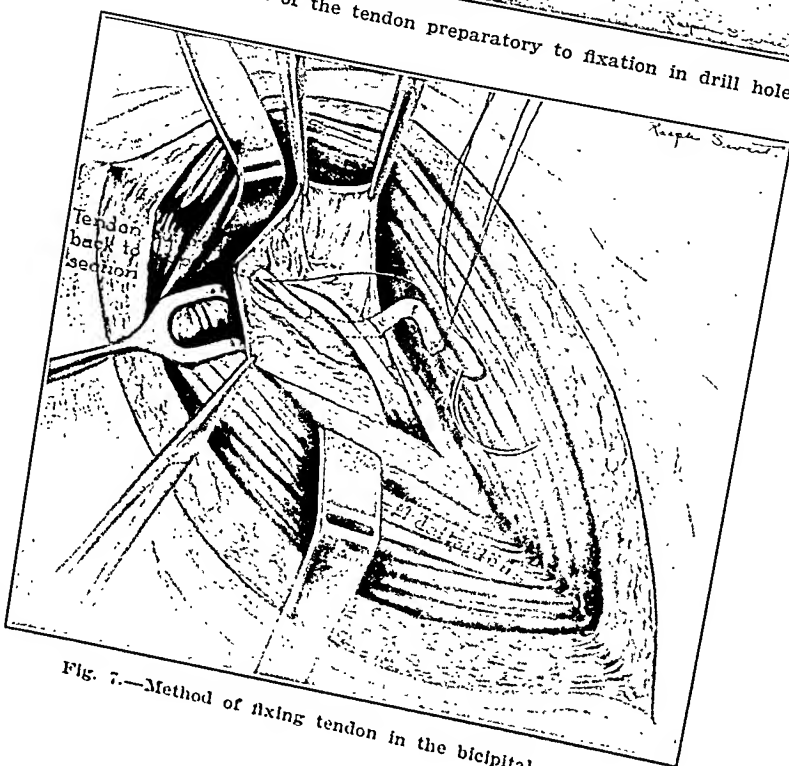


Fig. 7.—Method of fixing tendon in the bicipital groove.

abduction to 95 degrees and forward flexion to 120 degrees. External rotation was complete. The clicking sensation in the region of the bicipital groove had disappeared entirely. The patient complained of some weakness of the shoulder and of pain along the vertebral border of the scapula.

Treatment consisted of exercises, baking, and strapping across the vertebral border of the scapula. This latter fixation afforded considerable relief from the pain in this area.

Operation, Oct. 26, 1933.—The patient continued to complain of pain and tenderness at the base of the spine of the scapula.

Under local anesthesia this region was incised and the only possible source of trouble was what appeared to be some scar tissue overlying the spine of the scapula near the vertebral border. This mass was excised and the wound closed.

Convalescence following the operation was uneventful and the tenderness disappeared from the base of the spine of the scapula. The symptoms referable to slipping of the biceps tendon had disappeared entirely. Flexion and abduction of the shoulder, flexion and supination of the forearm, and the strength of the arm were quite satisfactory.

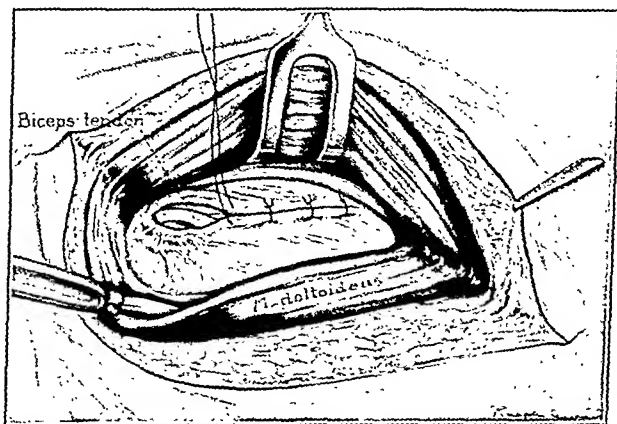


Fig. 8.—Closure of fibrous tissue sheath over the bicipital groove.

CASE 3.—Male. Chief Complaint:* Pain and weakness in the right shoulder. *Present Illness:* On Sept. 15, 1932, the patient fell a distance of twelve feet, landing on the palm of his right hand. He sustained a fracture of his right wrist and wrenched his right shoulder. The function of the wrist gradually returned to normal. Three months after injury, the patient still complained of dull pain, loss of strength, and a "cracking" sensation in the right shoulder joint.

Physical Examination.—The important findings were that abduction was limited to 90 degrees, forward flexion to 120 degrees, and that there was a loss of 50 per cent in external and internal rotations. Forced motions of the shoulder joint were painful. A rupture of the supraspinatus tendon was suspected.

Second Operation, Jan. 10, 1933.—An anterior incision was made separating the deltoid and pectoralis major muscles. There was no evidence of a tear of the supraspinatus muscle. The tendon of the long head of the biceps muscle was not in the intertubercular groove but was dislocated to the medial aspect of the lesser tuberosity.

*Presented through the courtesy of Dr. W. J. Cox, San Francisco, Calif., to whom we are indebted for the history and postoperative notes.

The tendon was easily replaced in its groove but redislocated on external rotation of the shoulder. The groove was deepened and the tendon held in its floor by drill holes and silk sutures.

Subsequent Course.—The patient had physical therapy for approximately five months. Examination then showed a normal range of abduction, forward flexion and rotation. The strength of the arm was satisfactory.

CASE 4.*—E. G., male, 56 years of age. *Chief Complaint:* Pain and weakness in the right shoulder. *Present Illness:* On July 27, 1933, the patient fell head first a distance of ten feet and was caught between two timbers with both arms abducted. Immediately after the accident he felt pain in both shoulders. A few days later there were pain, swelling, and ecchymosis over the anterior aspect of the right shoulder joint. On attempting to raise the arm "something seemed to fly out of place accompanied by pain and a snapping sensation which would almost knock him down." On lowering the arm to the side, "he felt something snap back into place" and the pain was relieved.

Physical Examination.—There were a small area of ecchymosis and a considerable area of tenderness over the anterior aspect of the shoulder joint. Active abduction was limited to 25 degrees and there was a slight limitation of rotation.

At this time a tentative diagnosis of injury to the short head of the biceps was made. Conservative measures were carried out for several months. On Oct. 23, 1933, the patient stated that for the past four or five days he had noticed that he had felt a sudden catch just lateral to the anterior axillary fold when he reached overhead with the right arm forward and the elbow flexed.

Examination elicited a painful "snapping" sensation in the region of the bicipital groove when the arm was externally rotated. A diagnosis of dislocation of the tendon of the long head of the biceps was made.

Operation, Oct. 24, 1933.—The operation was performed under local anesthesia. On retraction of the deltoid, the bicipital groove was readily brought into view. With abduction and external rotation the long head of the biceps tendon slipped inward over the lesser tuberosity. The bicipital groove was narrow, unusually shallow, and contained a mass of injected scar tissue. A flat cartilaginous excrescence, 1.5 cm. in size, was found loosely attached to the articular surface of the humerus immediately proximal to the lesser tubercle. On enlarging the capsular incision, the scar tissue filling the groove became continuous with the capsule and dissipated itself into the latter about 1 cm. proximal to the lesser tuberosity. After removal of the scar tissue and replacement of the tendon, the roof of the groove was reconstructed by suturing the fibrous tissue to two drill holes lying just below the lesser tuberosity. Following repair, manipulation of the arm and movement by the patient failed to displace the tendon.

Subsequent Course.—The pain had diminished and free movement of the joint was established. There was pain, however, on pressure over the region of the bicipital groove and on the extremes of abduction, external rotation at the shoulder, and on pronation and supination of the forearm. Supination was especially painful when performed against resistance.

Five months later, the patient complained of increasing pain and limitation of motion in the right shoulder. Examination showed tenderness along the course of the long head of the biceps tendon with severe pain on flexion and supination of the forearm. On abduction and external rotation, there was pain in the region of the bicipital groove. Internal and external rotations with the arm abducted to 70 degrees caused excruciating pain over the long head of the biceps.

*Presented through the courtesy of Dr. J. M. Meherin, San Francisco, Calif., to whom we are indebted for the history and postoperative notes.

The conclusion reached at this time was that the long head of the biceps tendon had redislocated from the bicipital groove and that further surgery would be necessary.

The patient was re-examined on April 12, 1934. His chief complaint was of pain, soreness in the shoulder, marked weakness and limitation of motion. The snapping sensation was entirely relieved. The pain in the shoulder was more severe than it had been when this patient was seen about three months before.

There was tenderness over the anterior aspect of the shoulder, particularly in the region of the bicipital groove. Attempts to carry out abduction and forward flexion were painful and limited. There was no snapping elicited on abduction with external rotation. Flexion and supination of the forearm, particularly the latter, were painful. The structures in the region of the bicipital groove were exceedingly tender.

Second Operation, April 20, 1934.—The old scar was excised and the bicipital groove was exposed. The deltoid was retracted laterally and, with rotation of the humerus, no definite injury to the supraspinatus or subscapularis was seen. The scar tissue over the groove was incised and the flattened tendon of the long head of the biceps was found displaced in front of the lesser tuberosity. The tendon above and below the groove was apparently normal without evidence of injury, nor was there fraying of its margins.

The reconstructive procedure consisted of removal of the origin of the long head of the biceps tendon from the glenoid and fixation of the tendon to the bicipital groove.

At the last examination, on Dec. 18, 1935, the patient stated that he was unable to do any work.

The examination showed that there was more atrophy of the muscles of the right shoulder than of the left shoulder. He complained of some tenderness over the bicipital groove and the tip of the coracoid process. Abduction and forward flexion of the shoulder could be carried out to 125 degrees and 180 degrees respectively. Rotations were limited to three-fourths of the normal range. All movements of the elbow were normal. The examination of the left shoulder showed complete range of active motion with the exception of internal rotation which was carried out to three-fourths of the normal range. All movements of the left elbow were free and painless.

CASE 5.—P. M., male, 46 years of age. *Chief Complaint:* Pain with inability to abduct the right arm. *Present Illness:* In January, 1935, the patient fell from a hay stack. He was holding a pitchfork with both hands and recollects that he landed on his hands, turned over, and struck heavily on his head and right shoulder. The right shoulder was severely "twisted" and the patient stated that he was unconscious for a short time. After the accident, he was unable to elevate the right arm. He did not seek professional advice but applied heat and liniments to the shoulder to alleviate pain. Some weeks later, on rotating the arm inward and then outward, he often felt a "pop" which, on occasions, was so loud that it could be heard across the room. Since his injury, he had suffered continually from an ache in the shoulder.

Physical Examination.—The patient was first examined on Jan. 14, 1936, one year after injury. Physically, he was a well-developed and well-nourished man. He held the right shoulder in a drooping position, but did not exhibit any obvious muscular atrophy nor any change in muscular contour. With the arm held in internal rotation, he was able to reach the complete range of flexion in the shoulder. On lowering the arm, when it reached an angle of 90 degrees, there was a sudden pain and a "grating" sensation and the arm fell to the side. Active abduction was limited to 30 degrees but could be increased passively to 90 degrees, at which

point the patient complained of pain referred to the insertion of the deltoid muscle. Flexion of the forearm against resistance both in pronation and in supination was equal on both sides and there was no alteration in the contour of the biceps. On palpation there was a little tenderness over the upper end of the intertubercular sulcus. On lateral rotation of the arm a "snapping" sensation could be distinctly elicited through the substance of the deltoid muscle in the region of the lesser tuberosity of the humerus. The long head of the biceps muscle could be palpated in its lower part but exhibited no abnormality of position.

Operation, Jan. 16, 1936.—The patient was placed in the sitting position with the arm slightly abducted. Under local anesthesia the deltoid muscle was split and the shoulder joint revealed. The long head of the biceps was found dislocated from its groove and lying medial to the lesser tuberosity. The supraspinatus tendon was intact. The long tendon of the biceps was severed and implanted into the greater tuberosity in such a manner that its normal direction of action was maintained and the proximal part of the tendon was excised. After closure of the wound, the arm was put up in abduction.

Subsequent Course.—On Feb. 23 the cast was discarded and baking, massage, and exercises were commenced. On March 27 examination showed some weakness on abduction, but there was no pain and no evidence of slipping of the tendon. A month later there was considerable improvement. Abduction and forward flexion were stronger and there was no pain.

The patient was re-examined on Nov. 22, 1938, two years later, at which time he did not experience any pain. The snapping over the rim of the bicipital groove had disappeared entirely. His chief complaint was weakness and limitation of abduction. He was able to carry on with his occupation as a farmer. He stated that his shoulder was "good enough" and that he did not wish to submit to any further surgery.

Examination disclosed some tenderness over the anterior aspect of the upper end of the humerus. In active motion of the right upper extremity he hunched his shoulder and there was a distinct disturbance in the scapulohumeral rhythm. Abduction was carried out largely by use of the scapula on the chest wall. The arm could be elevated passively to 30 degrees beyond the right angle and the patient could hold the arm in this position. In other words, range of passive motion was greater than active motion at the scapulohumeral joint.

From the present clinical findings, we feel that this patient may have had a partial rupture of the deep fibers of the insertion of the supraspinatus, a fact which could not be detected at the time of operation unless incisions had been made through the outer, intact portion of the tendon.

CASE 6.—H. S., male, 39 years of age. *Chief Complaint:* Pain and weakness in the right shoulder. *Present Illness:* The patient was a warehouseman. On April 9, 1938, he fell from a ladder striking his right shoulder against the edge of a table. He had severe pain in his right shoulder and arm immediately after the injury. The pain persisted and two days later he consulted his physician who prescribed physical therapy. At this time his shoulder was noticeably swollen and very painful.

Physical Examination.—The patient was examined by us on April 22, 1938, thirteen days after his injury. He held his right arm rigidly at his side and when attempts were made to move his shoulder there were spasm of the muscles and severe pain. Because of this pain, he was unable to abduct and flex his arm. There were marked tenderness over the bicipital groove, visible swelling in this region, and loss of tone of the belly of the biceps muscle. Active, external and internal rotations were impossible because of pain and spasm.

Roentgenograms of the right shoulder taken on April 11, 1938, showed no evidence of injury to the bone.

Conservative measures did not relieve him and operation was advised.

Operation, May 21, 1938.—An incision was made over the anterior surface of the right shoulder with separation of the fibers of the deltoid. The musculotendinous cuff involving the supraspinatus and infraspinatus muscles was found to be torn and retracted from its insertion. The tendon of the biceps was displaced from the bicipital groove and carried forward and inward with the torn musculotendinous cuff. Further dissection showed the tendon of the biceps wedged between the anterior and upper portion of the rim of the glenoid and the head of the humerus. This displacement prevented internal rotation of the humerus.

The falciform edge of the musculotendinous cuff was pulled down and fixed by strong silk sutures on the upper margin of the lateral surface of the humerus after the method of Wilson. Following reattachment of the cuff, the tendon of the biceps was readily replaced in the bicipital groove. The fibrous roof of the bicipital groove was sutured to the fascia and periosteum at its outer margin. The wound was closed with fine silk and a plaster of Paris spica was applied, holding the arm in 60 degrees abduction.

Subsequent Course.—Immobilization was continued for six weeks, when active exercises in abduction and rotations were begun. On Aug. 24, 1938, he showed a satisfactory improvement in function, although he complained of some pain and a "clicking" sensation on passive abduction and external rotation. He could abduct his arm actively to 150 degrees and rotate internally and externally to 50 per cent of normal.

The patient reported daily for physical therapy and monthly examinations revealed a gradual improvement in motions of the shoulder and in strength. He resumed his normal occupation in November, 1938. At the time of the last examination, Dec. 8, 1938, he stated that hard work often gave rise to pain in his right shoulder. He was instructed to continue with his work so that motion and strength could be increased in the shoulder.

ETIOLOGY

The clinical histories and operative findings in these cases are of special interest in relation to the observations made by Meyer on the cadaver as to the etiology of dislocation of the long head of the biceps brachii muscle. In this author's opinion displacement of the tendon is primarily the result of attrition of the joint capsule proximal to its attachments at the lesser tubercle. In his view the process is a gradual one and is supported by evidence of intermediate or transitional stages. Meyer is strongly, if not vehemently, opposed to the idea of trauma as an etiologic factor.

It is possible, in the cases outlined above, that the laborious occupations followed by these patients may have led to attrition of capsular attachments and that the accident simply produced the final displacement of the tendon. On the other hand, we cannot ignore the fact that in each of these cases there was a definite and severe accident in which wrenching of the shoulder joint was a prominent feature. In addition, and what we consider of the greatest significance, are the fairly uniform findings at operation. There were scar tissue, rupture of the fibrous roof

and capsular attachments in the region of the tuberosities, and, in some, an attendant lesion of the supraspinatus or subscapularis tendon, all of which show extensive local injury recent in origin. In the light of these findings, while recognizing from Meyer's work and from similar material which we have inspected the importance of attrition, we must conclude that in these cases trauma was the most significant factor in the production of the dislocation. Therefore, it is probably advisable to distinguish etiologically between acute traumatic dislocations and the chronic, progressive dislocations described by Meyer. Unfortunately, we have no clinical histories in Meyer's cases.

It would appear to us, after a study of these cases, that forcible lateral rotation of the arm was the principal cause of dislocation.

DIAGNOSIS AND DISCUSSION

An analysis of the foregoing cases will demonstrate that in each instance the patient gave a history, up to the time of his accident, of having been able to do work which involved strenuous use of his upper extremities. In other words, there was no history of previous complaint. In all cases, following upon a severe wrenching injury to the shoulder, there was complete and immediate disability. In four of the cases a snapping sensation was noted by the patient or by his physician a few days after the accident; in the fifth case, at the end of several months.

The outstanding clinical findings were: (1) swelling of the anterior aspect of the shoulder directly following the accident, (2) tenderness over the region of the long head of the biceps and the bicipital groove, and (3) limitation of motion and loss of strength in forward flexion and abduction. Pronation and supination of the forearm against resistance were painful, the pain being referred to the region of the bicipital groove. The outstanding feature, common to all six patients, was the "clicking" in the region of the bicipital groove which could be seen and felt on moderate abduction and lateral rotation of the arm.

Abduction with the arm laterally rotated is characteristically limited, and, if carried out passively, painful resistance is usually encountered. In the less acute stages, if first medially rotated, the arm may be carried above the head either actively or passively. This is more readily accomplished in flexion than in abduction. These movements are obviously permitted by the preliminary reduction of the dislocated tendon in the medial rotation. As the arm is carried from above the head to the side, when it reaches a point somewhat below the right angle, an audible or palpable snap may be evident which is associated with redislocation of the tendon. For reasons already discussed, redislocation occurs most readily in lateral rotation at about 45 degrees of abduction, and reduction is accomplished most easily by medial rotation with the arm at the side.

DIFFERENTIAL DIAGNOSIS

The conditions most likely to be confused with dislocation of the tendon of the long head of the biceps are: (1) rupture of the supraspinatus, (2) subcoracoid bursitis, (3) tenosynovitis of the biceps tendon, (4) snapping shoulder, (5) injury to the muscles which have their insertions on the margins of the bicipital groove, and (6) referred pain from irritation of the cervical nerve roots.

1. Rupture of the supraspinatus tendon may be very difficult of differentiation and it may occur simultaneously, as illustrated in Case 1. Both injuries occur in patients employed in laborious occupations and are followed by severe pain and loss of power in the arm, especially in forward flexion and abduction at the shoulder. There is tenderness around the anterior aspect of the shoulder in both conditions. In dislocation of the tendon of the biceps, however, the tenderness is more evident in the region of the bicipital groove than over the greater tuberosity of the humerus. In both conditions there is a disturbance of the scapulohumeral rhythm, but in our cases we did not find the definite jog and soft crepitus as the tuberosity disappears beneath the acromial process which we associate with lesions of the supraspinatus tendon. In dislocation of the tendon the disturbance in rhythm is often accompanied by a distinct snapping sensation on abduction and external rotation of the arm. Pain is also present on flexion of the elbow and supination of the forearm against resistance.

2. Subcoracoid Bursitis.—Codman stated in his earlier papers that he made the diagnosis of subcoracoid bursitis as if it were a distinctly separate thing from subacromial bursitis. Later he described the subcoracoid bursa as only a part of the subacromial bursa. He assumed, however, that the subcoracoid portion might be inflamed without involvement of the entire bursa. In such cases there is tenderness in the region of the lesser tuberosity of the humerus with crepitus and limitation of rotation of the shoulder. In one patient these symptoms were elicited and a diagnosis was made of partial dislocation of the biceps tendon from its groove. At operation no dislocation was found, but there was a marked thickening of the subcoracoid portion of the subacromial bursa. The operation was performed under local anesthesia, and we observed that when the arm was actively abducted and rotated externally this thickened portion impinged upon the common tendon of the origin of the short head of the biceps and of the coracobrachialis. This produced pain and a snapping sensation, symptoms which were exactly identical with those the patient had described prior to the operation.

The removal of this thickened portion gave complete relief.

3. Tenosynovitis of the tendon of the long head of the biceps may occur and in some cases crepitus in the region of the bicipital groove

with limitation of abduction and external rotation led to difficulty in diagnosis. At operation scar tissue was found involving the subacromial bursa with adhesions between its walls, and there were also adhesions between the tendon of the biceps and its synovial sheath. Our diagnosis was subacromial bursitis and tenosynovitis of the biceps tendon following direct trauma to the anterior aspect of the shoulder. This condition will be discussed at greater length in a future report.

4. Snapping shoulder has been described in cases in which a definite audible snap occurs with abduction and external rotation of the arm. We have encountered this condition only in cases of dislocation of the tendon of the long head of the biceps and in the case of subcoracoid bursitis described above.

5. Injury to the insertion of muscles at the bicipital groove is accompanied by pain and tenderness over the site of insertion with spasm of the affected muscle. These ruptures are usually the result of direct violence and are accompanied by sharp pain. There also may be a loud snap. A break in continuity of the tendon can be ascertained with loss of function.

6. We need only refer briefly to irritations of the nerve roots which may cause pain in the shoulder. The most important of these is arthritic involvement of the lower cervical spine. This condition is a frequent cause of pain in the shoulder, but a careful examination will show pain and limitation of motion of the involved cervical spine. Roentgenograms are also helpful in diagnosis. Referred pain caused by the pressure of a cervical rib or pain caused by a contracted scalenus anticus muscle (the Naffziger syndrome) may be confusing in diagnosis. It has been our experience, however, that in these conditions we do not find well-defined tenderness over the shoulder, limitation of motion, and spasm of the muscles which move the scapulohumeral joint.

THE OPERATIVE PROCEDURE

Operation is indicated for traumatic dislocation of the tendon of the long head of the biceps. We wish to emphasize here that the position of the patient for operation is important for adequate exposure of the structures of the joint. For a number of years it has been our practice to operate on children in the sitting position for arthrodesis of the shoulder. Only in this way can one estimate with accuracy the degree of abduction in the scapulohumeral joint. Within the past seven years, however, we have used this position for operations on rupture of the supraspinatus tendon, for calcified deposits in the subacromial bursa, and for complete exposure of the joint by the sabre-cut incision of Codman. With the patient in this position, the surgeon has access to all aspects of the shoulder.

In this procedure we have found the use of 1 per cent novocain to be almost ideal for exploration of the shoulder joint. It has the advantage

of permitting the patient to move his shoulder actively during the operation.

For exposure of the bicipital groove, the incision described by Codman should be used. With the arm at the side, the elbow flexed, and the forearm pointing straight forward, an anterior incision is made downward from just below the acromioclavicular joint. The fibers of the deltoid muscle are separated with exposure of the bicipital groove and the tuberosities of the humerus. By extension and rotation one can expose the major portion of the insertion of the supraspinatus, infraspinatus, teres minor, and subscapularis muscles. In our opinion the incision with separation of the pectoralis major and deltoid muscles, as used in some of our cases, is unnecessarily radical and need not be employed.

With dislocation of the tendon from its groove, the surgeon has the choice of division of the tendon at its origin from the glenoid with fixation of the tendon to the floor of the bicipital groove, or replacement of the tendon with reconstruction of the fibrous roof to prevent its redislocation. The first procedure is much the simpler. It was employed in Case 2, in which there was no associated injury to the supraspinatus tendon. A good functional result was obtained. The patient could flex his elbow, supinate the forearm, and flex at the shoulder against considerable resistance. Case 1 demonstrated, however, the importance of preservation of the function of the long head of the biceps when there is an associated lesion of the supraspinatus. In this patient fixation of the biceps tendon to its groove and the resulting disappearance of its intracapsular portion led to an unstable shoulder and an unsatisfactory result. The association of these two lesions would seem a definite indication for adequate repair of the supraspinatus and an effort to preserve the long head of the biceps by plastic repair of the roof of the bicipital groove. In a case of this type the use of fascia would seem appropriate.

SUMMARY

1. Six cases of dislocation of the biceps tendon resulting from injury are described.

2. In all cases the injury was followed by pain and swelling on the anterior aspect of the joint and complete disability of the affected shoulder.

3. The patients complained of pain with weakness and limitation of motion in forward flexion and abduction of the shoulder and pain on forced supination of the forearm against resistance with the elbow held in flexion.

4. The principal findings were swelling over the anterior aspect of the shoulder, tenderness, most pronounced over the bicipital groove, and a definite snapping sensation on abduction and external rotation of the shoulder.

5. In all cases operation disclosed a displacement of the tendon over the lesser tuberosity.
6. The best approach is obtained by the anterior muscle-splitting incision described by Codman.
7. In our opinion, local anesthesia and the sitting position greatly facilitate the operation.
8. No rules can be formulated as to the best procedure to be adopted in cases of dislocation of the tendon of the long head of the biceps. In uncomplicated dislocation it is highly probable that the quickest and best restoration of function can be obtained by fixation of the tendon in the bicipital groove. When other lesions occur simultaneously, an adequate result may be obtained by replacement of the tendon and repair by fascia of the roof of its groove.

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A BLIND METHOD OF NAILING FRACTURED FEMORAL NECKS

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AFTER a fracture of the femoral neck has been satisfactorily reduced and one wishes to fix the fractured fragments by indirect nailing, six unknown factors need to be solved. These unknowns are: (1) the place on the thigh where the skin incision is to be made; (2) the point on the long axis of the femur where the nail is to be started; (3) the vertical angle to be assumed by the nail and driver; (4) the length of nail to be used; (5) the horizontal angle to be assumed by the driver; (6) the point on the short axis of the femur where the nail should be started.

The protractor and measure described in this article is efficient, simple to use, and determines very quickly the first four unknowns. It does this without interfering with the taking of lateral x-rays, as described by Johnson, whose method I believe to be the most accurate and simplest of any so far described. The remaining two unknowns are solved with no trouble if one bears in mind certain anatomical facts.

In Fig. 1 the protractor and measure are illustrated. The measure consists of a metal plate (*D*), the leading edge of which is ruled off by small holes to designate quarter inches and larger holes inches. A protractor which slides (*C*) is mounted on the metal plate. A metal arrow (*B*), supporting two rests (*A*), is attached to the protractor. The protractor and arrow can be locked in any desired position by thumb nuts.

After reduction is thought to have been obtained and when the antero-posterior x-ray is taken, the metal plate is held against the thigh in the region of the trochanter (Fig. 2). The plate should be on or as near as possible the same horizontal plane as the trochanter. With gentian violet or some other suitable marking material, the upper and lower limits of the plate are marked on the skin of the thigh. This is done in order to insure the accurate replacing of the plate after it has been sterilized.

The four unknowns are determined from the image of the metal plate as it shows in the anteroposterior x-ray. In order to facilitate the determinations an ordinary celluloid rule and protractor are joined by a small winged nut (Fig. 3A). After the known factors have been determined from the x-ray, they are transferred to the sterilized plate and protractor as they are again held against the thigh in the same position as when the anteroposterior x-ray was taken.

DETERMINATION OF UNKNOWNNS

The straight edge of the celluloid protractor is placed along the leading edge of the metal plate as it shows in the x-ray. The rule is swung so that its center passes through the axis of the femoral neck (Fig. 3B). The holes in the metal plate show in the x-ray. The point where the rule crosses these holes is noted. This same point on the metal plate as

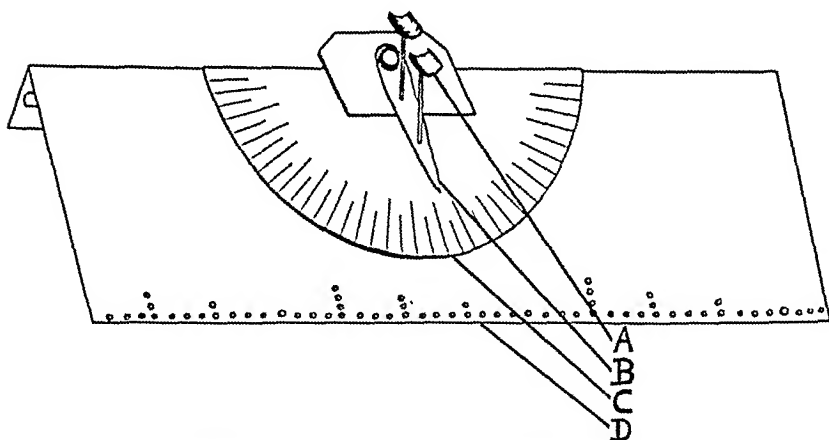


Fig. 1.—Illustration of the assembled metal protractor and measure.

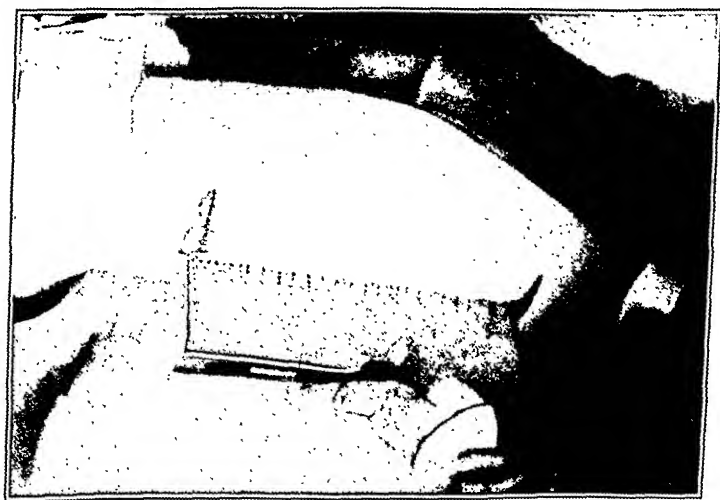


Fig. 3.—Showing the protractor and measure held against the thigh when the post-reduction anteroposterior x-ray is taken.

it is held against the thigh determines the place where the skin incision is to be made, solving the first unknown. The angle made by the center of the celluloid rule as it crosses the protractor is noted. The arrow on the metal protractor is swung to this same angle and locked. The protractor is slid on the plate so that the arrow designates the point where it has been determined the nail is to be started on the skin of the

thigh. The line of the arrow when carried to the femur determines the point on its long axis where the nail should be started, solving the second unknown. The vertical angle to be assumed by the nail and driver is the same as the angle noted where the celluloid rule crosses the protractor, thus solving the third unknown. Using the celluloid rule, the distance from the femoral head to the lateral surface of the trochanter is measured on the x-ray. This measurement is transferred

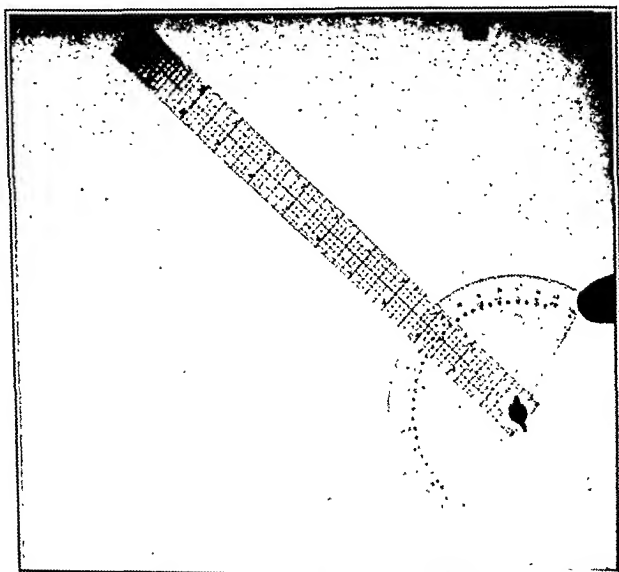


Fig. 3 A.—Illustration of the celluloid rule and protractor which facilitates the determination of unknown factors.



Fig. 3 B.—An anteroposterior x-ray of the hip, showing the image of the metal plate from which the unknown factors are obtained.

to the image of the metal rule, thereby correcting the x-ray measurement and giving the true length of the femoral neck, for the metal rule will enlarge in the same proportion as the bone. The length of the nail to be used is thus determined, solving the fourth unknown.

The two remaining unsolved factors are: (1) the horizontal angle to be assumed by the nail and driver; (2) the point on the short axis of the femur where the nail is to be started. The first is readily determined if one bears in mind that the normal degree of anteversion of the femoral neck is about 20° with the femur in a neutral rotatory position. If, on clinical examination, the knee is in a neutral rotatory plane, the nail and driver must be tilted 20° anteriorly from the horizontal. If the knee is in any other degree of rotation, the nail and driver will have to be changed in the horizontal plane, depending on the degree of change noted at the knee. The second unknown is easily determined for we know that the femoral neck comes off the anterior four-fifths of the medial surface of the femoral shaft. The nail must be started slightly anterior to the center of the short axis of the femoral shaft.

This method of determining the unknowns for blind nailing of femoral neck fractures has proved very satisfactory. It is not so foolproof that one should not check the progress of the nail as it is being inserted. In all cases in which this instrument has been used, one set of x-rays in both planes has been necessary to check the nail after it has been started. If this method is used, it is necessary that the affected leg be held in the same position between the first anteroposterior x-ray and when the nail is started. A careful assistant or a mechanical leg holder will accomplish this task.

THE USE OF ZINC PEROXIDE IN THE TREATMENT OF DIABETIC GANGRENE OF THE LOWER EXTREMITIES

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GANGRENE of the toe, foot, or leg is a frequent complication in diabetes and often has serious consequences because of its threat to the loss of limb or the loss of life.

It is well known that there is an underlying arterial sclerosis, and in some cases without any injury to the skin surface the arteries become plugged, collateral circulation is inadequate, and the area supplied by these vessels dies from loss of circulation. This results in a dry gangrene with little or no evidence of inflammation in the early stages of the process. In the later stages, however, when a line of demarcation has developed between the living and the dead tissue, a break in the continuity of the skin surface occurs, and the resulting wound becomes a portal through which contaminating bacteria may enter and produce an infection which changes profoundly the course of events, for the dry gangrene now becomes a wet gangrene.

However, in the majority of cases of diabetic gangrene of the extremities, the process is initiated by a break in the skin. This frequently starts around a toenail, where there has been undue pressure from a shoe. Occasionally it begins with a trivial wound inflicted when the patient has been going around with bare feet and has picked up a splinter or pin or has stubbed the toe with resulting abrasion. In some cases, there has been a crack in the skin from a fungus infection, occurring usually between the fourth and fifth toes. Sometimes, there has been a pre-existing corn or bunion which has been pared by the patient to the point where blood was drawn from the surface. At times, this has occurred following treatment by a chiropodist or a well-meaning member of the family.

Whenever there is a break in the skin, a portal of entry is immediately opened for the entrance of contaminating organisms, which frequently find themselves in an environment in which they can gain a foothold and multiply. Infection is favored because the tissues are poor in blood supply due to the underlying arterial sclerosis and they contain a higher percentage of sugar than is present in normal tissues. In the great majority of normal individuals, when contaminating bacteria get into a wound, no infection follows because the defensive forces of the body are promptly brought into play and the organisms are not able to gain a foothold. In the relatively few cases in which infections develop in normal people, usually only one species of bacteria can be cultivated. In

to the image of the metal rule, thereby correcting the x-ray measurement and giving the true length of the femoral neck, for the metal rule will enlarge in the same proportion as the bone. The length of the nail to be used is thus determined, solving the fourth unknown.

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wounds are the hemolytic streptococcus, *B. welchii*, and the anaerobic streptococci. The hemolytic *Staphylococcus aureus* runs a close second to this group.

Obviously, in the care of such conditions, prophylaxis is of extreme importance. If the activity of these organisms can be nullified as soon as they contaminate the wound, or in the case of dry gangrene before the solution of continuity of the skin between living and dead occurs, the organisms will not gain a foothold and infection will not occur.

However, in most instances the infection has already gained a foothold when the patient presents himself or herself to the surgeon. Invasion for a certain distance has already taken place. There may be a diffuse cellulitis, extensive gangrene of the part, or both.

The necessary treatment depends, to a large extent, upon the rapidity of the spread of the infection and the evidence of compromise of the circulation, as determined by oscillometric and surface temperature readings. The surface temperature readings must take into account the increased heat which occurs from the inflammatory process and any rise of general body temperature must also be discounted. In some cases where the circulation is fair, the evidence of general intoxication slight, the limits of local infection narrow, conservative measures may be, and usually are, advisable. However, it is of the utmost importance for the surgeon to determine by bacteriologic examination, aerobically and anaerobically, the number and nature of the various species of bacteria which are present, and further contamination by other species must be prevented. When these organisms have been determined, appropriate medication should be applied, which not only minimizes or nullifies the growth and activity of these organisms but in no way injures the tissues.

It has been found that Dakin's solution and other hypochlorites do not act favorably on tissues which have impaired circulation. While they may be able to liquefy the slough and to that extent remove some of the pabulum on which bacteria thrive, they inhibit the development of granulation tissue and thus delay the reparative process, which is likewise a barrier against bacterial invasion. Other antiseptics, in general, injure the tissue as much as or more than they do the infecting bacteria.

A substance has recently been found, however, which markedly inhibits the growth of the hemolytic streptococci and all anaerobic bacteria, including the organisms causing gas gangrene and the anaerobic streptococci. It neutralizes or inactivates the toxins formed by these organisms and at the same time encourages the reparative process by the stimulation of granulation tissue. This new substance is zinc peroxide, a white powder which is not chemically pure, which contains between 50 and 60 per cent ZnO_2 , some ZnO , ZnCO_3 , and ZnOH .

The white powder should be suspended in sterile distilled water and applied to every part of the wound surface. The wound should then be covered with fine meshed gauze soaked in the same material. This should

diabetic individuals, under the same circumstances, it is much easier for organisms to gain a foothold, and a number of species may be cultivated when infections develop.

When an infection becomes established with multiple species, these organisms frequently have a certain synergistic action which they cannot perform in pure culture. Saphrophytic organisms, particularly, multiply on tissues which are dead or dying or in which the blood supply is compromised. Then, there is a great likelihood of extensive and massive death of tissue, which we call wet gangrene.

In the foot, as in the hand, there are anatomic spaces between the muscles and around the tendons in which infection may and usually does spread deep beneath the surface. The extent of such spread is often difficult to determine from any surface signs. Not infrequently, gas gangrene organisms travel up, through, and along a deep muscle to the popliteal space without showing any signs of crepitation or even swelling of the superficial tissues. Only vague pain or deep tenderness may lead one to suspect this insidious spread. Bones and joints are often invaded early with certain of these organisms, and, when such invasion occurs, the infection becomes locked off in remote nooks and crannies which are frequently missed and cannot be easily exposed.

Among the organisms frequently found in diabetic gangrene are hemolytic streptococci and staphylococci and, likewise, anaerobic or microaerophilic organisms, particularly the organisms of gas gangrene, the anaerobic nonhemolytic streptococci, and the microaerophilic streptococci. Likewise, numerous gram-negative bacilli, both aerobic and anaerobic, including *B. coli* and the pyocyanus and proteus groups of bacteria, are found.

In the early stages of both the dry and the wet forms of gangrene, the presence of organisms and their nature can be determined by cultivation of the surface exudates. In the later stages, however, when the organisms have invaded deeply and, particularly, if the wounds or the margins of gangrene are extensive, it is necessary to take cultures from many different parts of the lesion in order to determine the organisms with which one has to deal. It is unlikely that there are any organisms in the depths that are not on the surface, but frequently organisms are present on the surface which have not invaded deeply at the time of the culture.

It is well known that bacteria differ very greatly in their power to invade. The hemolytic streptococci, the hemolytic *staphylococcus aureus* and the *B. welchii* often spread extensively and rapidly. The anaerobic streptococci, the nonhemolytic aerobic streptococci and staphylococci, and *B. coli* form an intermediate group as far as invasion is concerned. *B. proteus*, *B. pyocyanus*, and the saprophytic organisms usually limit their activity to the surface or to tissues which are already dead. The most important organisms in this entire list of the flora in gangrenous

there is no clinical evidence of infection in the wound, a secondary closure may be done with assurance of primary healing. If these organisms are found at the site of amputation, the wound should not be closed, but should be flushed with zinc peroxide and treated daily with this material until the organisms have disappeared from the wound and all signs of infection have ceased. Then, secondary closure may be contemplated. If hemolytic streptococci or the gas gangrene organisms have not been found at the initial culture, the wound at the amputation site may be closed. However, if the cultures which are taken from the gangrene at the time of operation or at the level of amputation yield hemolytic *Staphylococcus aureus* or anaerobic streptococci, the case should be very closely observed. The wound should be inspected daily, and if there is the slightest indication of infection, it should be opened. If hemolytic *Staphylococcus aureus* is present, the wound should be dressed with potent staphylococcus bacteriophage. If anaerobic streptococci should be present, it should be dressed with zinc peroxide. If none of the four malignant types of organisms described above is found in the initial cultures, the amputation wound may be closed with every expectation of primary healing. Still, the case should be watched carefully for any general symptoms of infection, and, if the wound is not perfectly comfortable, it should be examined and appropriate measures taken.

The use of sulfanilamide is indicated in addition to the zinc peroxide if hemolytic streptococci are present. Its efficacy with other organisms is questionable. There is some evidence that sulfapyridine has a somewhat wider application, but our data are not yet sufficient to warrant any definite statements in this report.

SUMMARY

I have attempted to show how important bacteriologic studies are in connection with diabetic gangrene. Both aerobic and anaerobic cultures should be taken at the earliest possible time from several areas of the lesion when it is first presented to the surgeon, so that he may know as soon as possible with what organisms he has to deal.

Infections are usually due to a mixture of organisms, and, in the diabetic, the synergistic action of these bacteria is more likely to produce serious consequences than in normal individuals.

Zinc peroxide is the most effective antiseptic which we know of to minimize the possibility of the establishment of infection at the time of the primary injury or at the time of the first solution of continuity of the surface protection. It may, likewise, be employed during the period of preparation before operation, providing organisms are present which are susceptible to it, such as the hemolytic streptococci and all types of anaerobic organisms.

If these organisms are present at the site of amputation, it should be used as a prophylactic to prevent the development of infection in the

be covered with compresses saturated with sterile distilled water and these compresses in turn covered with vaseline gauze or some other impermeable material to prevent evaporation. The dressing should be changed every twenty-four hours, the old material irrigated off, and a new dressing applied. It is important to use material which has been proved to be effective in the production of oxygen, and it is essential that adequate contact be obtained between the zinc peroxide suspension and every part of the wound surface.

This material, when suspended in water or moistened by body fluids, slowly gives off oxygen, producing a highly oxygenated environment wherever it comes in contact. Likewise, it forms hydrogen peroxide and these two properties result in the inhibition or death of all anaerobic organisms and certain aerobic organisms which are susceptible to the peroxides, notably the hemolytic streptococcus and the pneumococcus. There is some inhibition also to the growth of the staphylococci, but not to the same extent.

There is a limited field of usefulness for this material in the stages of infection in which the patient generally comes to the hospital. It would be useful if it were available at the time of the initiation of the process with the first break in the skin. If patients come to the doctor at this stage, it should be used as a prophylactic against infection. However, if infection has invaded deeply into the tissues so that it is not possible to get contact, zinc peroxide cannot be expected to stop the spread of the process without a preliminary operative procedure.

In anticipation of operation, no matter at what level the operation is to be done, time should be given, unless otherwise contraindicated, for the determination of the bacterial flora. As mentioned above, all of the organisms found on the surface are potential invaders in diabetic patients and may be assumed to be passing up along the lymphatics or directly through tissues to higher levels, even as high as the line of amputation.

The organisms most invasive will almost invariably reach the highest level. It must be assumed that these are present and it must be realized that if hemolytic streptococci, anaerobic streptococci, the gas gangrene organisms, or hemolytic *Staphylococcus aureus* are present, evidences of their activity must be looked for at the site of amputation and appropriate measures taken to prevent their multiplication after amputation. When the amputation is done, cultures should be taken from the stump, particularly in the region of the blood vessels and lymphatics, so that within forty-eight hours it can be definitely proved whether or not these organisms are present.

When the original cultures from the surface reveal gas gangrene organisms and hemolytic streptococci, the wound should be left open until the cultures taken at the amputation site have been reported. After forty-eight hours, if the cultures are negative for these organisms and

TOTAL CYSTECTOMY FOR CANCER

A CRITICAL REVIEW

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INTRODUCTION

COMPLETE removal of the bladder has become established as an important and valuable surgical procedure. It has its particular value in the treatment of certain cancers of the bladder, which are curable only if removed early and completely.

The benign and some of the malignant papillomas respond fairly well to electrocoagulation, but, in the sessile infiltrating types of cancer of the bladder, such treatment has been disappointing and radiotherapy offers little more than palliation at best.

Since more than three-quarters of cancers of the bladder arise on its base, thereby involving the ureteral orifices or vesical sphincter,²⁴ excision of the tumor or partial cystectomy is usually not feasible. In the majority of cases, then, only total extirpation of the bladder offers a chance for cure.

We have chosen to divide this paper into two parts: I. A critical review of the literature on total cystectomy for cancer and, II, an analysis of personal cases of ablation of the bladder for malignant disease, with a brief description of our technic for prostatico-seminal-vesiculo-cystectomy.

I. REVIEW OF THE LITERATURE

A. *History of Cystectomy.*—The first work on cystectomy was carried out on animals, and Gluck and Zeller¹⁰ in 1881 reported the first successful cystectomies in dogs whose ureters were transplanted to the skin.

In 1887 Bardenheuer⁵ performed the first total cystectomy on a man suffering from cancer of the bladder. The ureters were abandoned in the pelvis. The patient died of uremia fourteen days after the operation.

In 1889 Pawlik¹⁰⁷ carried out the first successful cystectomy, which was upon a woman. First, the ureters were transplanted to the vagina and, twenty-four days later, the bladder was extirpated. The patient was living sixteen years later. Kümmell⁷⁷ performed cystectomy with ureterourethral transplant in 1890. The patient died of shock. From a man suffering with cancer of the prostate with secondary invasion of the bladder, Küster,⁷⁸ in 1891, removed the prostate and bladder and

stump; or, if infection develops in the stump, it should be used at the earliest possible time in order to control such infection. If reamputation is necessary, it should be used immediately to prevent establishment of infection in the second operative site.

The method of employment of zinc peroxide has been given in detail.

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bladder, very large tumors of the bladder, and carcinoma of the prostate invading the neck of the bladder. Cystectomy has been carried out for other maladies as well, as may be seen in Table II.

TABLE II
TOTAL CYSTECTOMY
INDICATIONS

INDICATION	NUMBER OF CASES
Cancer of bladder	205
Squamous cancer of bladder	7
Cancer of bladder—uterus	8
Multiple papillomas of bladder	8
Cancer of prostate	8
Cancer of uterus	6
Sarcoma of bladder	5
Cancer of urethra	3
Cancer of cervix	2
Sarcoma of uterus	1
Cancer of vagina	1
Totals	254

With a few exceptions, cystectomy has been considered an operation of despair, which, to a large extent, explains the mortality attendant on this procedure. As has been noted, the majority of vesical malignancies take origin from the base of the bladder and invade the ureteral orifices, with resulting hydronephrosis and infection. These patients, from the renal standpoint, become poor surgical risks and their dilated thin-walled ureters are difficult to transplant, particularly to the colon.^{73, 92} The mortality of cystectomy, however, has gradually fallen, due, in particular, to improvements in ureterointestinal anastomosis and to the employment of multistage procedures. An important step further in this direction will be made when early radical intervention is undertaken.^{10, 36, 113} Quinby, for example, will perform cystectomy only if there are no evident metastases, if the patient has one normal kidney, and if his physical condition is sound.

C. Methods of Diversion of Urine.—1. *Ureters Abandoned in the Depths of the Wound:* When Bardenheuer performed the first cystectomy in man, he was forced to abandon the ureters in the pelvis because of the condition of his patient at the end of the operation. Verhoogen and de Graeuwe,¹⁴⁵ in 1896, deliberately followed this procedure. Eleven cases in which the ureters were treated in this manner were collected.

2. *Ureters Brought to the Skin of the Abdominal Wall:* This group includes ureteral transplantation to the hypogastrium, to the iliac region, and into the edges of the cystectomy wound.^{16, 105}

Gigon¹³² in 1856 and Agnew¹⁰⁵ in 1881 proposed ureterocutaneous transplant but did not use it clinically. In 1881 Gluck and Zeller successfully performed cystectomy in dogs and transplanted the ureters to the skin.

was the first to combine cystectomy with ureteral transplantation to the rectum. The patient died, however, five days later, of peritonitis and pyelonephritis.

In this country, Martin⁹⁰ in 1899 was the first surgeon to remove the bladder for cancer. He performed a hysterocystectomy for malignancy of the uterus and bladder. The ureters were transplanted to the rectum. The patient died of peritonitis four days after operation.

Two hundred and thirty-six cases of total extirpation of the bladder for cancer have been tabulated from the literature and eighteen personal cases not previously reported have been added (Table I). This

TABLE I
TOTAL CYSTECTOMY

NUMBER OF CASES-----	254
OPERATIVE MORTALITY -----	87
PERCENTAGE MORTALITY -----	34.2%

METHOD OF DISPOSAL OF URETERS	ONE STAGE			TWO STAGES			TOTAL NO. OF CASES	PER- CENTAGE MORTAL- ITY
	NO. OF CASES	NO. OF POSTOP- ERATIVE DEATHS	PER- CENTAGE MORTAL- ITY	NO. OF CASES	NO. OF POSTOP- ERATIVE DEATHS	PER- CENTAGE MORTAL- ITY		
Abandoned in wound	11	5	45.4	--	--	--	11	45.4
Skin of ab- dominal wal	28	6	21.4	11	--	0.0	39	15.3
Lumbar ureterostomy	6	2	33.3	12	--	0.0	18	11.1
Nephrostomy	1	1	100.0	11	1	9.09	12	16.6
Urethra	6	6	100.0	--	--	--	6	100.0
Vagina	12	4	33.3	2	1	50.0	14	35.7
Bowel exclu- sion	11	6	54.5	6	2	33.3	17	47.0
Colon	63	38	60.3	74	15	20.3	137	38.0
Totals	138	68	49.2	116	19	16.2	254	34.2

latter group will be more fully discussed. The cases comprising the series recently reported by Higgins,^{57, 58} Nesbit,¹⁰⁰ Kidd,¹³ and others and some of the cases of Beer⁸ and Smith¹³² are not included in this compilation because details necessary for their evaluation were not recorded. Cystectomy for exstrophic bladders is not considered in this study.

In the past, Bovée (1901),¹¹ Druebert (1903),³⁰ Rafn (1905),¹¹⁵ Verhoogen (1909),¹⁴⁵ Watson (1913),¹⁵² Scheele (1923),¹²¹ Papin (1925),¹⁰³ and Bompert (1931),¹⁰ among others, have similarly listed the reported cases and discussed the subject.

B. Indications for Total Cystectomy.—The outstanding indication for complete cystectomy is for infiltrating cancer of the base of the bladder involving either the vesical outlet, ureteral orifices, or both. Other reasons for vesical ablation include recurring multiple papillomas of the

bladder, very large tumors of the bladder, and carcinoma of the prostate invading the neck of the bladder. Cystectomy has been carried out for other maladies as well, as may be seen in Table II.

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cedures. They also prefer having the ureters accessible for dilatations and lavage and claim that the special apparatus for collecting the urine is efficient.

Many surgeons, including Papin,¹⁰⁵ Fey³⁶ and Rovsing,¹¹⁹ believe that cutaneous transplant (anterior or lumbar) causes less damage to the kidneys than any other method of urinary diversion.

5. *Ureters Transplanted to the Urethra:* Sonnenburg² in 1882 was the first surgeon to employ transplant to the urethra. This was in a case of exstrophy. In 1890, Kümmell⁷⁷ performed urethral transplant in conjunction with cystectomy. He brought the right ureteral catheter out through the urethra. In all, six cases of transplant to the urethra have been reported, with six deaths. Obviously, such a transplant presupposes a one-stage operation, which is a disadvantage. Certainly the results in these cases suggest why the procedure has been abandoned.

6. *Ureters Transplanted to the Vagina:* Pawlik,¹⁰⁷ in 1889, not only performed the first successful cystectomy but was the first to utilize ureterovaginal transplant. At the first stage he carried out the transplant vaginally, using indwelling ureteral catheters. Twenty-four days later extraperitoneal vaginal cystectomy was done for cancer. The patient was alive and well sixteen years after operation.

In all, fourteen such cases have been tabulated. An attempt is usually made to obtain continence by closing the vaginal orifice, the new bladder, the vaginal cavity, emptying through the urethra. This, however, has not been particularly successful in practice so that usually collecting devices are necessary and the ureters are open to the possibility of dilatation and ascending infection. The ureters cannot be reached, as they can in ureterocutaneous transplants, for dilatations and lavages. This method of dealing with the ureters, therefore, has fallen into disrepute and has not been used during the past twenty years.

7. *Ureters Transplanted to Excluded Bowel:* The ureters may be transplanted to a segment of either partially or totally excluded bowel.

Maucclair¹⁴⁵ in 1894 first suggested total exclusion of the rectosigmoid by division of the sigmoid loop, sigmoid colostomy, and closure of the proximal end of the distal limb, with implantation of the ureters into the latter structure. This he performed in dogs.

Krönig⁷⁶ first employed this method in conjunction with cystectomy in 1906. The first stage consisted of exclusion of the rectosigmoid and sigmoid colostomy. Twelve days later, the ureters were transplanted into the blind sigmoid and hysterocystectomy for sarcoma of the uterus was carried out. The patient was alive five years later. A similar procedure was carried out by Thies,¹³⁷ Schmieden,¹²³ and Lindström,⁸³ the latter two surgeons transplanting the ureters at a separate operation before cystectomy was done.

In 1912, Lemoine⁵⁰ performed a cystectomy and transplanted the ureters to the rectum. Later, because the patient suffered from renal

Laurenze¹⁰⁵ in 1888 brought a ureter, which he had accidentally cut, to the skin. The following year Le Dentu¹⁰⁵ chose this procedure for a woman with a uterine cancer which had invaded the ureters. Gynecologists often have had recourse to it when confronted with surgical accidents to the ureter. Wassiljew¹⁵⁰ in 1895, however, was the first to employ ureterocutaneous transplant with cystectomy. In all, thirty-nine cases utilizing this method have been recorded. Smith¹³² performed the operation with cystectomy eleven times, but the cases were not published in detail and consequently are not included in this study.

Suturing the ureters to the edges of the cystectomy wound naturally presupposes a one-stage procedure; further, as the wound heals, scar tissue causes stenosis of the orifices. Chute¹⁹ and Fuchs⁴¹ in 1925 were the last to utilize this method.

Papin¹⁰⁵ stressed the superiority of iliac ureterostomy because of the low mortality associated with it, the efficiency of the collecting apparatus, and the accessibility of the ureters for dilatation and lavage.

Maximovitch⁹² and Smith,¹³² among others, noted the frequent occurrence of sloughing of the distal ends of the ureters, often necessitating reoperation. Many surgeons object strenuously to the apparatus employed for collection of the urine.

3. *Lumbar Ureterostomy*: Roving¹¹⁹ in 1906, was the first surgeon to perform cystectomy with lumbar ureterostomy and Whiteside,⁴³ in this country, carried out a similar procedure in the same year. Eighteen such cases have been collected. The disadvantages of this type of ureterostomy, in addition to those held in common with all cutaneous transplants, are the inaccessibility of the ureters to the patient who must care for them and the unsatisfactory collecting apparatus necessary because of their dorsal position.

4. *Nephrostomy*: Nephrostomy has long been employed as a means of temporary or permanent drainage of the kidney,¹⁶ but it was not until 1905 that Watson¹⁵¹ first suggested its use in conjunction with cystectomy. Three years later, Marion⁸⁹ performed the first nephrostomy-cystectomy, which he accomplished in two stages. Cabot,¹⁵ in 1909, followed a similar procedure in a man with cancer of the prostate, cystectomy and partial prostatectomy being done. Twelve such cases were found.

Nephrostomy has the advantage, in common with ureterocutaneous transplants, of a low rate of mortality, but the operation of nephrostomy causes damage to the kidney, the drainage of the lower half of the kidney is poor, and the dorsal position of the collecting apparatus is inconvenient.

The advocates of nephrostomy and ureterocutaneous transplant point with pride to the low operative mortality associated with these pro-

published since 1926, only 19 patients, or 25.3 per cent, died from the operation. By 1927 Fedoroff²² had done 9 cases without a death. Coffey,²² in 1933, reported 11 cases with only 3 deaths, and two years later Quinby¹¹² listed 10 cases with only 2 deaths. Among our last 14 patients suffering from cancer, there were 3 deaths following uretero-enterostomy and radical removal of the bladder and adjacent organs. As may be noted from Table I, the mortality for ureterointestinal transplant done in two stages was only 20.3 per cent. This figure, however, does not take into account the patients who died of the operation for transplanting the ureters, thereby not entering into these computations. This point will be discussed later. One factor which has decreased the mortality in this group has been the employment of a two- or three-stage procedure. The mortality will fall further when the patients are operated upon early, when the cancer is limited to the bladder, and when the kidneys are healthy and the ureters are not dilated.

Transplantation of the ureters to the bowel has the advantage of having the urine controlled by a sphincter. This factor, however, must be weighed against the lower mortality associated with cutaneous transplants.

D. The Technique of Cystectomy.—1. *In the Male:* If the cancer involves only the lateral or posterior wall of the bladder without affecting the prostate or seminal vesicles, cystectomy may be all that is necessary, although it has been proved that the limits of a malignant growth cannot be ascertained by inspection. Microscopically, isolated islands of cancer cells may be found far removed from the primary growth. In most instances, therefore, complete prostatoseminal-vesiculocystectomy is indicated; it becomes necessary when the prostate is the site of primary cancer or is secondarily invaded by tumor.

Since a cancerous bladder is always septic, it should be removed unopened, although some surgeons insist upon exploratory cystotomy before cystectomy is attempted. Because of the potential infection, most surgeons prefer an extraperitoneal technique. In many instances, however, the serosa covering the fundus is either adherent or is involved by cancer. In such cases the serosa must be resected and left on the bladder, whereupon the peritoneum is repaired.

Most operations have been performed through a suprapubic approach, although a combined abdominoperineal or perineoabdominal technique has many advantages.

If the suprapubic approach is utilized,² the serosa may be separated from the bladder laterally and posteriorly, the bladder stripped anteriorly from the symphysis by cutting the pubovesical ligaments, the lateral vesical ligaments divided, thereby controlling the major blood supply, and the ureters sectioned. The dissection is then carried posteriorly, separating the bladder from the rectum and dividing the urethra between the prostate and bladder.

infection, he excluded the rectum, making it communicate with the urethra, and attempted to pull the sigmoid through the anal sphincter to allow both fecal and urinary continence. Unfortunately, the sigmoid retracted and the patient died of sepsis.

Verhoogen¹⁴⁵ in 1908 and Lengemann⁸¹ in 1911 utilized a different type of procedure. Verhoogen excluded the iliocecal region while Lengemann excluded the entire ascending colon; both carried out iliotransverse colostomy, appendicocutaneous transplant, and anastomosis of the ureters to the cecum.

Berg⁶⁰ isolated a segment of ilium, anastomosed one end to the sigmoid and transplanted the ureters to the blind end, thereby forming a partially excluded loop of bowel into which the urine drained.

In all, seventeen cases based on the foregoing principle were found.

These procedures, complicated as they are, were proposed because of the desire to abolish ascending renal infection. Judging by the cases reported, however, the advantages are only theoretical. Pyelonephritis is not eliminated, stenosis of the ureteral orifices occurs just as readily as in ureterointestinal anastomosis, and the amount of surgery is greatly increased. In the face of the recent successes experienced with ureteroenterostomy, exclusion of the bowel has become unnecessary.

8. *Ureterointestinal Anastomosis*: Gluck and Zeller,⁴⁶ in 1881, made an unsuccessful attempt to combine cystectomy and ureterointestinal anastomosis in dogs.

Ten years later, Küster⁷⁸ performed rectoureteral transplant and a perineoabdominal extraperitoneal prostatocystectomy, but without success. Tuffier,¹⁴¹ in 1895, was the first to perform an effective transplant of the ureter to the bowel. Martin,⁹⁰ in 1899, was the first surgeon in this country to attempt the operation in conjunction with cystectomy. One hundred and thirty-seven cases of cystectomy have been collected in which the ureters were transplanted to the colon. The subject of ureterointestinal implantation, with a critical study of the surgical principles involved, has been recently made and need not be repeated here.⁶⁰

Many surgeons, particularly the French, have objected strenuously to intestinal transplant because of its higher mortality from operation, arising from peritonitis and pyelonephritis, and later morbidity from progressive hydronephrosis and renal infection. Bompert¹⁰ even stated that "transplantation of the ureters to the intestine should be completely abandoned in total cystectomy for cancer." Beer,⁸ though he feels that, theoretically, a procedure allowing sphincteral control of the urine is to be preferred, for practical reasons resorts to ureterocutaneous transplant with which he enjoys a low operative mortality and fairly satisfactory results.

Many of the Russian, German, British, and American surgeons, however, have persisted in developing ureteroenterostomy, with the result that, of the 75 cases of cystectomy with ureterointestinal anastomosis

on a patient without adding the shock of cystectomy. There are many plans for two- or more-stage procedures. Both ureters may be transplanted at one stage, or one ureter may be transplanted at the time of cystectomy. A three-stage procedure is also utilized; i.e., two transplants and cystectomy.

Table I shows the mortality depending on the number of stages used. This comparison, however, is not a true picture of results because, particularly in cases of ureterointestinal anastomosis, many patients for whom cystectomy is planned die from the anastomosis and therefore the cases are not recorded. Obviously, cystectomy itself has a low mortality, probably under 5 per cent, and even some of these deaths are due in reality to factors secondary to the transplanted ureters.

F. *Results of Cystectomy.*—In the 254 cases of total cystectomy, there were 87 operative deaths, a mortality of 34.2 per cent (Table III). This is the lowest rate yet reported for cystectomy and is due to the inclusion of recent cases in which the results have been greatly improved. The actual mortality at the present time, therefore, is lower than the figure given.

Among those 11 patients in whom the ureters were abandoned in the depths of the wound, there were 5 operative deaths. None was reported as living more than two years. Because of its high mortality and poor results, this method has become of historical interest only.

TABLE III
SUMMARY OF RESULTS

METHOD OF DISPOSAL OF URETERS	TOTAL NO. OF CASES	NO. OF POST- OPERATIVE DEATHS	SURVIVAL BUT WITHOUT FOLLOW-UP	SURVIVAL (DEAD OR ALIVE AT LAST REPORT)			
				UNDER 1 YR.	1 TO 5 YR.	5 TO 10 YR.	10 YR. OR MORE
Abandoned in wound	11	5	1	3	2	—	—
Skin of abdominal wall	39	6	4	19	8	2	—
Lumbar ureterostomy	18	2	7	7	1	0	1
Nephrostomy	12	2	—	5	3	0	2
Urethra	6	6	—	—	—	—	—
Vagina	14	5	1	6	1	0	1
Bowel exclusion	17	8	1	3	3	2	—
Colon {One stage	63	38	1	12	10	1	1
{Two stages	74	15	9	27	19	4	—
Totals	254	87	24	82	47	9	5

Among those 39 patients in whom the ureters were transplanted to the skin of the abdominal wall, there were only 6 deaths from the operation, or 15.3 per cent, in spite of the fact that the majority of the operations were performed in one stage. This figure compares favorably with resections of the bowel for cancer and is the major reason why many surgeons utilize it.

Only about 1 of 4 patients comprising this group lived one year or more, though Beer reported 2 patients alive after eight and one-half and

If the prostate and seminal vesicles as well are to be removed suprapubically, they are separated from the rectum posteriorly, the prostate is freed all around, and the distal portion of the prostatic urethra is sectioned.³⁷

Harris,⁵³ in 1901, performed a similar operation except that he first carried his dissection anteriorly, cut the pubovesical ligaments, and freed the anterior surface of the prostate. He then divided the membranous urethra and, by a retrograde method, pulled the prostate, vesicles, and bladder out from below upward. Coffey,²² Ward,¹⁴⁹ and one of us (F. H.)⁵⁹ have utilized this technique more recently. We, however, have abandoned it because of the occurrence of bleeding from the plexus of Santorini before exposure is sufficient to permit its control. Beer⁸ criticized this technique because, in his opinion, it tends to milk cancer cells into the lymphatics.

In 1891, Küster⁷⁸ first utilized a combined perineoabdominal approach. It has also been well described by Albarran.² With the patient in the lithotomy position, the prostate, seminal vesicles, and base of the bladder are separated from surrounding tissues by a technique similar to that of Young's radical perineal prostatectomy. The prostatic urethra is divided. A suprapubic incision is then made and the bladder freed, allowing removal of the organs *en masse*.

If the prostate is involved by cancer, it is more easily separated by the perineal route; whereas, if it is free of malignancy, it is more easily stripped off the rectum from above.

We prefer an abdominoperineal technique which is described in the second part of this paper.

Beer⁶ performs suprapubic extirpation of the bladder with transection of the prostate with the cautery. Ward¹⁴⁹ has also used this method.

Drainage of the resultant extraperitoneal suprapubic and pelvic space is essential. Many surgeons prefer a Mikulicz or quarantine pack, while others use tube drains. Perineal drainage is a great advantage because of its dependency. Poor drainage of this dead space, which fills with serum, may lead to the formation of an abscess.

2. *In the Female:* The technique most often used in the female is suprapubic extirpation.^{2, 79, 136} If the uterus or its appendages are involved, cystohysterectomy may be indicated.³

If the cancer involves the urethra, or is primary there, urethrocyectomy is necessary.^{33, 40} This may be accomplished by a vaginoabdominal or abdominovaginal route. One of us (F. H.) performed cystectomy solely by the vaginal route in one case. Recently, Shaw¹²⁷ evolved a ureterorectal transplant and cystectomy by the vaginal route. This method has not yet been employed clinically.

E. *Number of Stages.*—Most surgeons are now convinced that multiple-stage operations are of distinct advantage in these cases.^{34, 36, 121} Ureteral transplantation, particularly if to the colon, is enough of a tax

The following authors had patients who, when last reported, had been living three years or more: Fedoroff, six years; Coffey, four years; Hinman, three and one-half years; Coffey, three years; Ssolowoff, three years.

Those listed below reported cases in which their patients lived four years or more but died from the causes indicated:

TABLE IV

AUTHOR	YEARS OF LIFE AFTER OPERATION	CAUSE OF DEATH
Fishel	13	Bronchopneumonia, no recurrence
Vehrs	6	Recurrence of cancer
Von Winiwarter	5½	Pyelonephritis, pulmonary abscess
Ward	5½	Carcinomatosis
Fedoroff	5	Recurrence of cancer
Hinman	4	Recurrence of cancer

Of the 73 patients who survived operation, on whom complete or partial follow-up records were secured, 35 lived one year or more.

The chief causes of operative death following cystectomy were acute pyelonephritis and shock. Recurrence or metastasis of cancer caused the majority of late deaths. Other causes have been listed in Table V.

G. Discussion.—In order to arrive at a more accurate conclusion concerning the risk of total extirpation of the bladder to the patient of today, we must base our study on cases in which the urinary stream was diverted by abdominal and lumbar ureterocutaneous transplant and ureteroenterostomy. To evaluate the latter method, we should consider only recent cases because of improved surgical principles now employed.

From Table I, it may be concluded that cystectomy combined with ureterocutaneous transplant either to the abdominal wall or the lumbar region promises a surgical mortality of about 15 per cent.

If a two-stage ureteroenterostomy-cystectomy is performed and if the patient survives the primary ureteral transplant, the mortality will be about 20 per cent. If those dying from the first stage of the procedure are included, the mortality will be above 30 per cent. The average duration of life of those patients surviving the operation is about the same, whether their ureters are transplanted to the skin (anteriorly or posteriorly) or to the intestine. The surgeon must decide which is of most importance to the patient, the risk of the operation or the patient's comfort after the operation.

The hope for improvement in the results of cystectomy lies in early radical surgery when cancer is limited to the bladder, when the ureters are healthy and the condition of the patient is such that he can stand an extensive surgical procedure. This is particularly true in ureteroenterostomy.

Lack of space does not allow the tabulation of the published cases gathered from the literature. On pages 864 and 865 (Table VI), are listed the date of cystectomy, the name of the surgeon (or reporter), and the references. The cases are divided according to the method of disposal of the ureters.

four years respectively and 1 who died of cancer and tuberculosis five years after operation. It is interesting to note, however, that in the 11 cases in which operation was done in two stages, there were no operative deaths.

Among those 18 patients for whom lumbar ureterostomy was performed, there were 2 operative deaths, or 11.1 per cent. In only 1 case was a good result obtained; Brongersma's patient was alive fifteen years after operation when last reported. Only 1 other patient lived more than one year. In this group, also, it may be seen that no operative deaths resulted among those patients for whom a two-stage operation was chosen.

There were 2 operative deaths in the nephrostomy group of 12 cases but in 1 of these (personal case) prostatoseminal-vesiculocystectomy was carried out only because of severe sepsis of the bladder from which the patient would have shortly succumbed. He was not operable. Only this one patient, of 11 treated by a two-stage procedure, died from the operation.

One of Marion's patients was still living thirteen years after the operation and one of Thomas' patients died sixteen years after operation of pulmonary and intestinal tuberculosis. Smith and Marion each reported a case in which death occurred three years after operation, from carcinomatosis.

As noted above, under the discussion of the six patients subjected to cystectomy in addition to transplantation of the ureters to the urethra, all died from the operation.

In the group of 14 cases in which vaginoureteral transplant was done, there were 5 operative deaths, or 35.7 per cent. Except for Pawlik's patient, who was living sixteen years after operation, the results have been poor, only 1 other patient having lived more than one year.

The ureters were transplanted to partially or completely excluded bowel in 17 cases, with 8 postoperative deaths, or 47 per cent. Krönig's patient was still alive five years after operation and 1 treated by Thies was living three years after operation. Gironcoli reported on a patient who died of uremia after five and one-half years, while Thies's other patient died four and one-half years after operation of cachexia and pulmonary tuberculosis.

Ureterointestinal transplant was carried out in conjunction with cystectomy in 137 cases, with 53 deaths, a mortality of 38 per cent. This figure, of course, does not take into account those patients who died as a result of preliminary diversion of the urinary stream. It is not fair to quote the mortality for the whole group and accept it as the true mortality at the present time because recent improvements in ureterocenterostomy have lowered the operative risk. Thus, in the 75 cases reported since 1926, there were only 19 operative deaths, a mortality of 25.3 per cent.

II. SUMMARY OF PERSONAL EXPERIENCE WITH TOTAL CYSTECTOMY FOR CANCER

A. Analysis of Personal Cases.—There has been nothing published in the literature dealing with the true risk to the patient for whom ureteroenterostomy and total cystectomy are planned. All the authors who have presented statistics regarding their personal results with cystectomy have failed to include the patients for whom radical surgery was originally intended but who for one reason or another had preliminary ureteral transplantation only. Since 1925 we have performed ureteroenterostomy on fifty patients suffering from cancer.

1. *Ureteroenterostomy Without Cystectomy:* Twenty-four of these patients never came to radical removal of their tumors (Table VII). Eighteen of this group died as a result of the ureteroenterostomy and 5 patients died within ten months of surgery, while the other patient committed suicide one year and three months later; he was inoperable.

We have classified these patients into two groups, operable and inoperable, based on clinical findings before surgery and at the operating table. In this group of 24 patients who had only preliminary diversion of the urinary stream, only 7 had cancers which might have proved operable. Six of the 7 died from the effects of the diversion, 1 of shock, 4 of renal sepsis, and 1 of circulatory failure. The other patient died ten months later of renal infection.

Of the remaining 17 patients, 12 died after operation: 5 of renal sepsis, 3 of generalized peritonitis due to faulty surgical technique, 2 of bronchopneumonia, 1 of bilateral hydronephrosis, and 1 of lobar pneumonia. Of the other 5 patients, 4 died of cancer within ten months, while 1 committed suicide one year and three months after surgery.

2. *Nephrostomy With Cystectomy:* Nephrostomy and nephrectomy for bilateral hydronephrosis were performed on a man for whom ureteroenterostomy and finally cystectomy were planned. Because of severe sepsis of the bladder, however, abdominoperineal prostatoseminal-vesiculocystectomy was carried out twenty-five days later. Not only was he a very poor risk from the standpoint of sepsis and renal impairment, but he was found to be inoperable. He died twenty-four hours after the second operation.

3. *Ureteroenterostomy With Cystectomy:* Twenty-five of the 50 patients with cancer underwent ureteroenterostomy and cystectomy, all during the past five and one-half years (see tabulated personal cases appended). Ten of these (40 per cent) died following operation, while 6 are living and well up to three and one-half years after surgery.

Of these 25 patients, 17 were considered operable. Seven (41.1 per cent) of these died shortly after cystectomy: 2 of generalized peritonitis, 2 of pelvic abscess and sepsis, 1 of renal sepsis, 1 of pneumonia, and 1 of massive pulmonary atelectasis. Three patients died later of cancer,

TABLE VI—CONT'D

DATE	SURGEON	DATE	SURGEON	DATE	SURGEON
1898	von Winiwarter ⁶⁵	1924	Smitten ¹³³	1931	Riches ¹¹⁶
1898	Schede ¹⁵¹	1925	Pleschner ¹⁰⁹	1931	Riches ¹¹⁶
1899	Weljaminow ¹³⁶	1925	Smith, G. G. ¹³²	1932	Bell ⁹
1899	Krause ⁷⁴	1925	Ward ¹⁴⁹	1932	Ward ¹⁴⁹
1899	Martin ⁹⁰	1925	Chute ¹⁹	1932	Dodd ²⁹
1899	Martin ⁹⁰	1925	Fedoroff ³⁴	1932	Ward ¹⁴⁹
1900	Whiteside ⁴³	1925	Simon ¹²⁸	1933	Hinman*
1901	Krause ⁷⁵	1925	Simon ¹²⁸	1933	Hinman ⁶⁰
1902	Woolsey ¹⁵⁷	1925	Maximovitch ⁹²	1933	Hinman ⁶¹
1902	Lund ⁸⁵	1926	Quinby ¹¹¹	1934	Hinman ⁵⁹
1903	Vaughan ¹⁴³	1926	Smith, G. G. ^{130, 132}	1934	Hinman ⁶¹
1903	Schwysen ¹²⁵	1927	Fedoroff ³⁴	1934	Smith, G. G. ¹³²
1904	Carson ¹⁷	1927	Maguire ⁸⁷	1934	Smith, G. G. ¹³²
1904	Wilms ¹⁵⁵	1927	Smith, G. G. ¹³²	1934	Hinman ⁶¹
1905	Lindner ¹³⁶	1927	Pleschner ¹¹⁰	1934	Hinman ⁶¹
1905	Quervain ¹⁵²	1928	Ssolowoff ¹³⁴	1934	Ward ¹⁴⁹
1906	Verhoogen ¹⁴⁵	1928	Coffey ²²	1934	Hinman ⁶¹
1906	Schwartz ¹²⁴	1928	McIvor ⁹⁴	1934	Hinman*
1906	Wilms-Jaeger ¹⁵⁹	1928	Ssolowoff ¹³⁴	1935	Griffin ⁵⁰
1907	Pauchet ¹⁰⁶	1928	Ssolowoff ¹³⁴	1935	Hinman ⁶³
1907	Rouffart ¹⁴⁵	1929	Smith, G. G. ¹³²	1936	Quinby ¹¹⁴
1907	Rouffart ¹⁴⁵	1929	Aschner ⁴	1936	Ward ¹⁴⁹
1907	Enderlen ³²	1929	Coffey ²²	1936	Hinman*
1909	Lauenstein ¹⁵²	1929	Ssolowoff ¹³⁴	1936	Hinman*
1909	Petrow ¹⁰⁸	1930	Hryntschakes	1936	Hinman*
1911	Fedoroff ³³	1930	Ssolowoff ¹³⁴	1936	Hinman*
1911	Beer ⁶	1930	Coffey ²²	1937	Hinman*
1911	Hagner ⁵¹	1930	Coffey ²²	1937	Hinman*
1912	Moscovicz ¹⁰	1930	Ssolowoff ¹³⁴	1937	Hinman*
1912	Samborsky ¹²⁰	1930	Coffey ²²	1937	Hinman*
1913	Gorache ¹²⁰	1930	Coffey ²²	1937	Hinman*
1915	Fedoroff ³³	1930	Coffey ²²	1937	Hinman*
1917	Fedoroff ³³	1930	Ssolowoff ¹³⁴	1937	Hinman*
1918	Smitten ¹³³	1930	Coffey ²²	1937	Hinman*
1918	Jefferson ⁶⁹	1931	Nitch ¹⁰¹	1937	Hinman*
1918	Smith, G. G. ¹³²	1931	Nitch ¹⁰²	1937	Hinman*
1920	Egger ³¹	1931	Coffey ²²	1938	Hinman*
1920	Egger ³¹	1931	Pedroso ²³	1938	Hinman*
		1931	Vehrs ¹⁴⁴	1939	Hinman*

*Previously unreported cases.

one in four years, one after one year and eight months, and one seven months after cystectomy. One patient died after two years and four months, autopsy revealing bilateral atrophic pyelonephritis with renal insufficiency, without evidence of cancer. The remaining 6 patients are living and well for the following periods: three and one-half years, two years and four months, two years and three months, one year, six months, and two months.

Eight patients in this group were found to be inoperable. Three died after operation, 1 of acute pyelonephritis, 1 of renal sepsis and pelvic abscess, and 1 of a pelvic abscess and pneumonia. The other 5 patients died later of cancer, 1 in two years and eight months, 1 after one year and six months, 1 at one year, and 2 at the end of four months.

Of these 50 cases, then, only 24 were considered to be operable and 3 of these patients died later of cancer. Therefore, in the light of our

TABLE VI

DATE	SURGEON	DATE	SURGEON	DATE	SURGEON
<i>Cystectomy With Ureters Abandoned in Wound</i>					
1887	Bardenheuer ⁵	1903	McCosh ^{93, 125}	1913	Rafin ¹⁵²
1896	Verhoogen ¹⁴⁵	1903	McCosh ^{93, 125}	1920	Egger ³¹
1898	Bardenheuer ¹⁴⁵	1905	Hamonic ⁵²	1920	Egger ³¹
1898	Bardenheuer ¹⁴⁵			1926	Chute ¹⁹
<i>Cystectomy With Ureters to Skin of Abdominal Wall</i>					
1895	Wassiljew ¹⁵⁰	1913	Keyes ⁴³	1927	Hazanoff ⁵⁵
1901	Harris ⁵³	1915	Cifuentes ²⁰	1927	Hazanoff ⁵⁵
1902	Garre ⁴⁹	1915	Beer ⁶	1927	Hazanoff ⁵⁵
1905	Verhoogen ¹⁴⁵	1915	Beer ⁶	1927	Beer ⁶
1905	Bruni ¹⁰	1919	Beer ⁶	1927	Hazanoff ⁵⁵
1908	Marion and Legueus ⁸⁹	1919	Nassauer ¹²¹	1928	Hazanoff ⁵⁵
1910	Héresco ⁵⁶	1920	Papin ¹⁰⁵	1928	Maister ⁸⁶
1910	Zuckerkindl ³⁹	1922	Messtorff ⁹⁵	1928	Beer ⁶
1910	Tenney ⁴³	1922	Rochet and Thévenot ¹¹⁸	1928	Beer ⁶
1911	Héresco ⁵⁶	1925	Fuchs ⁴¹	1930	Just ⁷¹
1911	Héresco ⁵⁶	1925	Fuchs ⁴¹	1931	Godard ⁴⁷
1911	Keller ⁴³	1925	Beer ⁶	1932	Winsbury-White ¹⁵⁶
1912	Héresco ⁵⁶	1925	Chute ¹⁹	1935	Walters ¹⁴⁸
<i>Cystectomy With Lumbar Ureterostomy</i>					
1906	Rovsing ¹¹⁹	1908	Straus ¹³⁵	1915	Crosbie ²⁶
1906	Rovsing ¹¹⁹	1909	Martin ⁹¹	1925	Fuchs ⁴¹
1906	Whiteside ⁴³	1911	Brongersma ^{13, 14}	1927	Antonucci ³
1907	Rovsing ¹¹⁹	1912	Furniss ⁴²	1930	Hryntschak ⁶⁸
1907	Fenwick ³⁵	1913	Marion ¹⁰³	1934	Freiberg ⁴⁰
1908	Fenwick ³⁵	1913	Morton ⁹⁹	1935	Freiberg ⁴⁰
<i>Cystectomy With Nephrostomy</i>					
1908	Marion ¹¹⁸	1909	Marion ¹¹⁸	1917	Smith, G. G. ¹²⁹
1909	Cabot ¹⁵	1909	Marion ¹¹⁸	1922	Joseph ⁷⁰
1909	Heitz-Boyer ²⁸	1912	Marion ¹⁰³	1934	Hyman ⁶⁰
1909	Marion ¹¹⁸	1914	Thomas ¹³⁸	1937	Hinman (see text)
<i>Cystectomy With Transplant to Urethra</i>					
1890	Kümmell ^{31, 77}	1896	Albarran ¹	1903	Keyser ¹⁵¹
1895	Lindner ⁸²	1897	Goepel ⁴⁸	1920	Egger ³¹
<i>Cystectomy With Transplant to Vagina</i>					
1889	Pawlik ¹⁰⁷	1900	Mann ⁸⁸	1908	Pollosson ¹³⁶
1894	Kossinsky ⁹⁶	1901	Mann ⁸⁸	1910	Cunco ¹³⁶
1896	Zeller ¹⁵⁸	1901	Smith, A. L. ¹⁴⁵	1910	Pollosson ¹³⁶
1897	Modlinski ⁹⁸	1902	Robson ¹¹⁷	1925	Fuchs ⁴¹
1898	Modlinski ⁹⁸	1908	Seidel ¹²⁶		
<i>Cystectomy With Ureters to Excluded Bowel</i>					
1906	Krönig ⁷⁶	1912	Lemoine ⁵⁰	1922	Scheele-Schmieden ¹²¹
1907	Berg ¹⁵²	1912	Thies ¹³⁷	1926	Lindström ⁸³
1908	Verhoogen ¹⁴⁵	1913	Thies ¹³⁷	1929	Gironeoli ⁴⁵
1908	Verhoogen ¹⁴⁵	1921	Schmieden ¹⁰	1934	Gironeoli ⁴⁵
1908	Berg ¹⁵²	1921	Rubritius ¹²¹	1937	Gironeoli ⁴⁵
1911	Lengemann ⁸¹	1921	Schmieden ^{122, 123}		
<i>Cystectomy With Ureters Transplanted to Colon</i>					
1891	Küster ⁷⁸	1920	Egger ³¹	1931	Ward ¹⁴⁹
1895	Tuffier ¹⁴⁰	1921	Loewe ⁸⁴	1931	Ssolowoff ¹³⁴
1895	Giordano ¹⁴⁵	1921	Fedoroff ³¹	1931	Coffey ²²
1896	Chalot ¹¹	1922	Smith, G. G. ¹³²	1931	Smith, G. G. ¹³²
1897	Turetta ¹⁴²	1922	Smith, G. G. ¹³²	1931	Ssolowoff ¹³⁴
1897	Giordano ¹⁴⁵	1923	Lindström ⁸³	1931	Ssolowoff ¹³⁴
1897	Wendel ¹⁵⁴	1923	Fishel ³⁸	1931	Coffey ²²
1897	Küster ⁷⁸	1923	Fedoroff ³¹	1931	Coffey ²²

present knowledge, only 21 had a chance for cure. Thirteen of these died from the effects of surgery, 2 died later of renal infection, while 6 (28.5 per cent) are living and well.

A lower mortality would have resulted had candidates for such radical surgery been more carefully selected. Many of the earlier patients had ureteroenterostomy done by various methods (Higgins, Coffey I, Coffey II). Now that experimental and clinical observations have led to a standardized technique for transplantation of the ureters to the sigmoid and cystectomy or prostatoseminal-vesiculocystectomy, surgical errors have decreased and our results have improved correspondingly.

Approximately one-half the patients under discussion were known to be inoperable, but most of these operations were done in the earlier years. Of the 11 patients who underwent cystectomy during the past two and one-half years, only 1 was inoperable to our knowledge. Only 3 of the

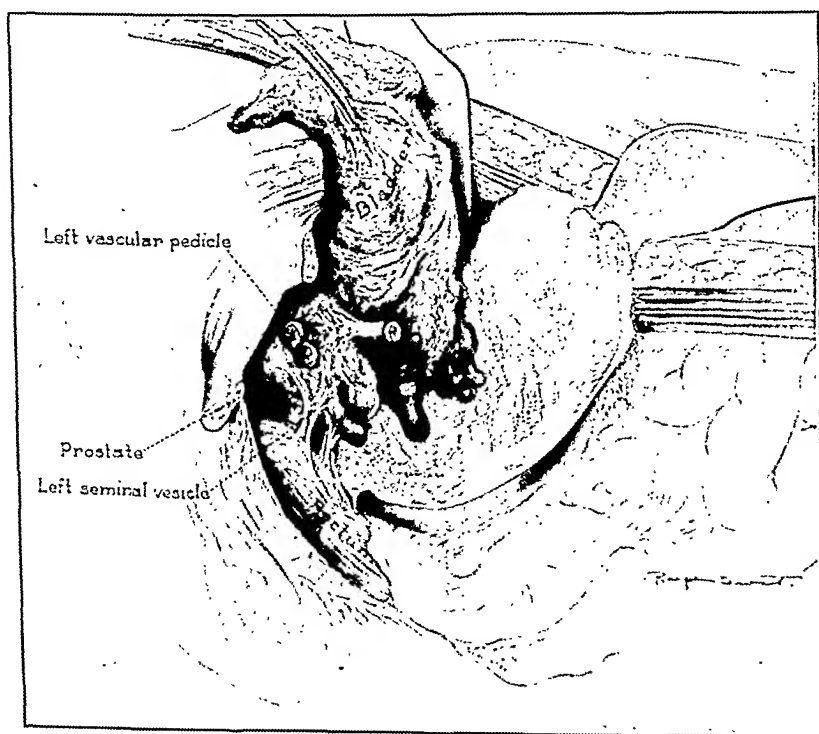


Fig. 2.—Method of prostatoseminal-vesiculocystectomy. By blunt dissection the bladder is freed down to the prostate anteriorly and the vesicular area posteriorly.

last 14 patients upon whom cystectomy was performed died in the hospital. In 1, a pelvic abscess developed when one ureter pulled out of the sigmoid; the second died of massive collapse of the lung; the third, at autopsy, had a perfect technical result and only bronchopneumonia was found to explain his death.

SURGERY

TABLE VII

FIFTY PATIENTS WITH CARCINOMA

- 24 had ureteroenterostomy only:
 7 operable
 6 died following surgery
 1 died later of renal infection
 17 inoperable
 12 died following surgery
 4 died later of cancer
 1 committed suicide
 1 had nephrostomy and cystectomy:
 Inoperable; died following surgery
 25 had ureteroenterostomy and cystectomy:
 17 operable
 7 died following surgery
 3 died later of cancer
 1 died later of atrophic pyelonephritis
 6 living and well
 8 inoperable
 3 died following surgery
 5 died later of cancer

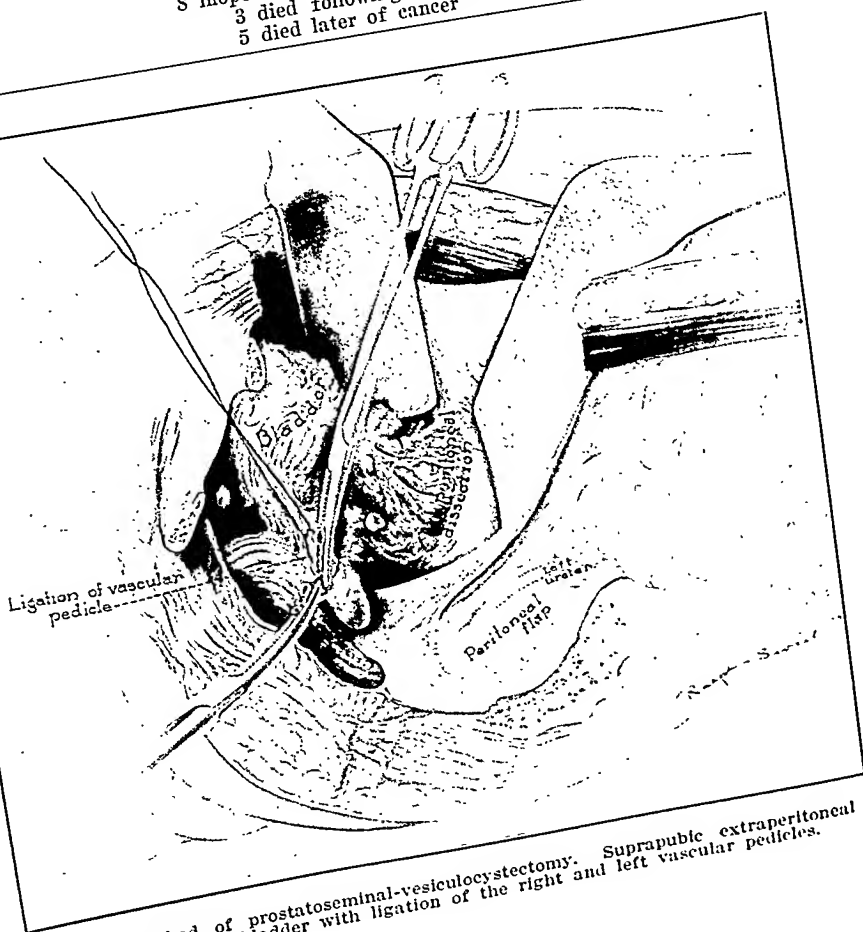


Fig. 1.—Method of prostatoseminal-vesiculocystectomy. Suprapubic extraperitoneal exposure of the bladder with ligation of the right and left vascular pedicles.

III. TECHNIQUE OF ABDOMINOPERINEAL TOTAL PROSTATOSEMINAL-VESICULO-CYSTECTOMY

Table VIII lists the various approaches utilized in this group of personal cases. In women, cystectomy only has been performed unless the urethra has been primarily or secondarily involved. We have always planned radical excision of the prostate and seminal vesicles along with the bladder in men, but in one case this was not possible because of the extent of cancer in the pelvis. Recently, a combined abdominoperineal

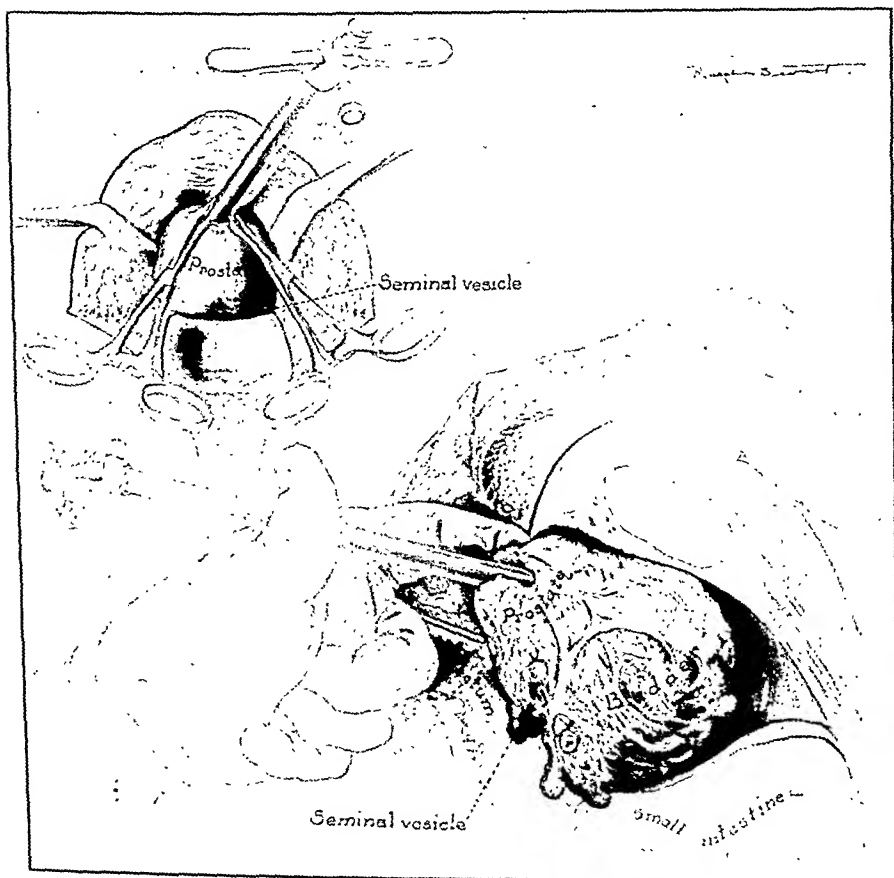


Fig. 5.—Method of prostatoseminal-vesiculocystectomy. The prostate and vesicles have been dissected free as for a radical prostatoseminal vesiculectomy.

operation has been evolved which seems to offer many advantages. It involves a clean excision of the bladder, prostate, and seminal vesicles, combining suprapubic cystolysis and radical perineal prostatoseminal-vesiculocystectomy.

The first operative stage consists usually of right ureteroenterostomy.⁶³ Two or three weeks later, the left ureter is transplanted to the sigmoid and radical removal of the bladder is carried out in the following manner:

Abdominal incision closed
without drainage

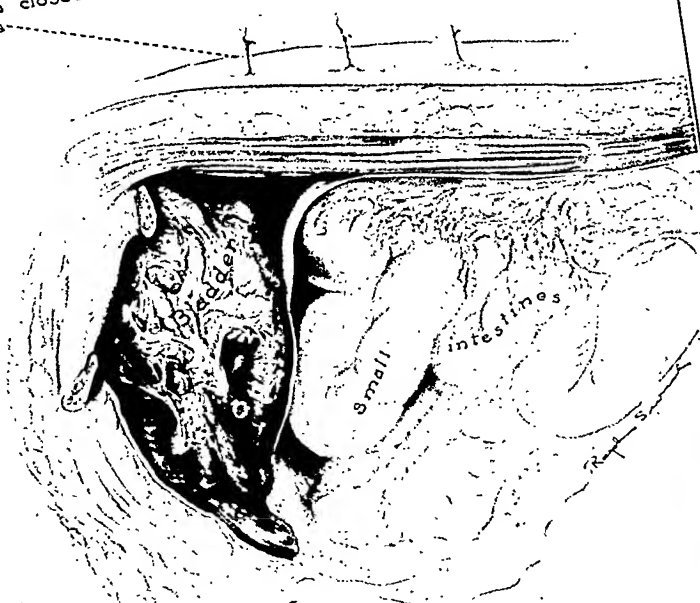


Fig. 3.—Method of prostateseminal-vesiculocystectomy. The abdominal incision is closed without drainage and the patient placed in lithotomy position.

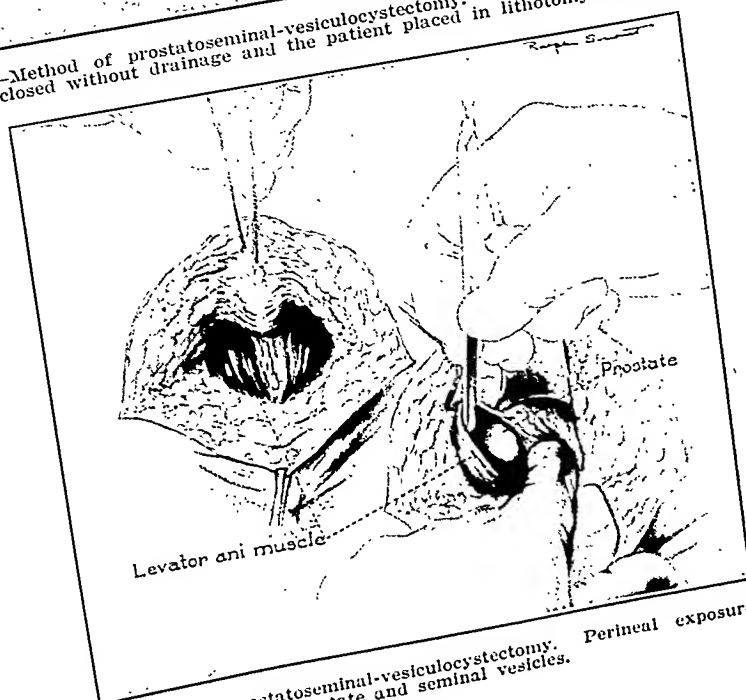


Fig. 4.—Method of prostateseminal-vesiculocystectomy. Perineal exposure of the prostate and seminal vesicles.

TABLE IX
URETEROINTESTINAL TRANSPLANTATIONS FOR CANCER—WITH CYSTECTOMY

REFERENCE IF PRE- VIOUSLY REPORTED	SEX AGE	INDICATION, OPERABILITY	PREVIOUS TREATMENT IF ANY	OPERATION	NO. OF STAGES	RESULTS, AUTOPSY FINDINGS
C. T.*	M 61	Carcinoma of bladder Operable	Fulgura- tions	9/13/33: Left ureterointestinal trans- plant (Higgins' method); abdominal right ureter ligated 9/12/33: Bilateral ureterointestinal trans- plant (Coffey No. 2 technique); bladder freed down to neck 10/21/33: Perineal vesiculectomy prostateseminal-	1	Died 5 days after operation of general- ized peritonitis (left ureter separated from the bowel)
F. R. ⁵⁰	M 49	Carcinoma of bladder, invading prostate Inoperable	Left neph- rolith- otomy 1918, 1933; many fulgura- tions	9/13/33: Left ureterointestinal trans- plant (Higgins' method); abdominal right ureter ligated 9/12/33: Bilateral ureterointestinal trans- plant (Coffey No. 2 technique); bladder freed down to neck 10/21/33: Perineal vesiculectomy prostateseminal-	1	Died 5 days after operation of general- ized peritonitis (left ureter separated from the bowel)
F. H. ⁶¹ (Case 5)	M 65	Carcinoma of bladder, invading prostate; bilateral hydroneph- rosis Inoperable	None	(Patient in uremia) 9/22/33: Bilateral 12/15/33: Bilateral nephrostomy plant with probe and suture trans- ureter; right ureter tied off; prostateseminal-vesiculectomy	1	Died 2 yr. and 8 mo. after operation; cause; 1 yr. after operation had right nephrectomy
M. E. ⁶¹ (Case 1)	F 60	Squamous cancer of bladder and urethra Operable	None	12/6/33: Bilateral ureterointestinal transplant (seven-suture method) 1/18/34: Vaginal urethrocyctectomy	2	Died 10/18/38, 4 yr. after operation; re- currence vaginally, bilateral pyonephro- sis with secondary atrophy of left kid- ney; after operation had x-ray therapy for recurrence
J. Y. ⁵⁰ (Case 3)	F 68	Carcinoma of bladder, recurrent Operable	Fulgura- tion	1/6/34: Right ureterointestinal trans- plant, Coffey No. 3 technique, with ex- traperitoneal catheter; left ureter to skin; suprapubic cystectomy	1	Died thirteenth day after operation Autopsy: Abscess in vesical space, acute left hydronephrosis with infection; right hydronephrosis; right ureter be- low the catheter undergoing necrosis

*Previously unreported.

After the ureter has been transplanted, dissection of the peritoneum from the fundus and posterior surface of the bladder is begun before the peritoneum of the wound proper is closed. After closure of the peritoneum, working extraperitoneally, the serosa is freed from the bladder well down into the cul-de-sac (Fig. 1). Next the bladder is freed an-

TABLE VIII
TECHNIQUE USED IN 26 RADICAL OPERATIONS FOR CANCER

18 men:	1
Abdominal cystectomy	11
Abdominal prostatoseminal-vesiculocystectomy	6
Abdominoperineal prostatoseminal-vesiculocystectomy	
8 women:	1
Vaginal urethrocyctectomy	5
Abdominal cystectomy	1
Vaginoabdominal urethrocyctectomy	1
Abdominovaginal cystourethrectomy	1

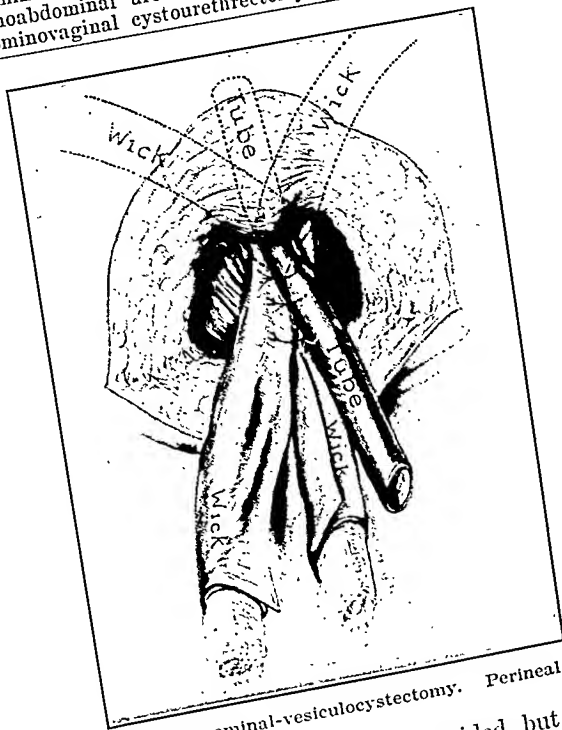


Fig. 6.—Method of prostatoseminal-vesiculocystectomy. Perineal drains are placed anteriorly and the pubovesical ligaments are divided, but the pubic area is not disturbed because bleeding from the plexus of Santorini is sometimes very difficult to control. By blunt dissection carried laterally, first one and then the other vesical pedicle is isolated, doubly clamped, and tied. This controls the major blood supply. If possible, the seminal vesicles and part of the prostate are then freed from the rectum and extraperitoneal tissues (Fig. 2). The farther down the dissection is carried

F. E.*	M 65	Carcinoma of bladder Operable	Fulgura- tion	3/22/36: Left ureterointestinal implant (simple seven-suture method with car- rier); right ureter placed in intestinal bed	2	Died fifth day after operation Autopsy: Leak at site of anastomosis pneumonia
E. B. H.*	M 58	Carcinoma of prostate, invading bladder Inoperable	None	5/6/36: Right ureterointestinal trans- plant completed; abdominal prostato- seminal-vesiculocystectomy		
				5/21/36: Left ureterointestinal trans- plant (simple seven-suture method with carrier)	2	Died one and one-half yr. after opera- tion, carcinomatosis
A. H.*	F 64	Carcinoma of bladder Operable	Many ful- gurations	6/17/36: Right ureterointestinal trans- plant, same technique, and abdominal prostatoscinal-vesiculocystectomy		
				10/15/36: Left ureterointestinal trans- plant (simple seven-suture method with probe and cautery)	2	Died 4/12/39, 2 yr. and 4 mo. after operation of renal insufficiency Autopsy: Bilateral atrophic pyeloneph- ritis, no hydronephrosis or cancer
K. K.*	F 38	Carcinoma of bladder Inoperable	Supra- pubic cystot- omy one month earlier	11/5/36: Left ureterointestinal trans- plant (simple seven-suture method with traperitoneal cystectomy)	2	Died 4 1/2 mo. after operation, carcinoma in wound
				12/3/36: Right ureterointestinal trans- plant, same technique; suprapubic cys- tectomy		
L. A.*	M 54	Squamous carcinoma of bladder Operable	Supra- pubic cystot- omy 7 mo. ear- lier, ex- tensive fulgura- tion	12/21/36: Left ureterointestinal trans- plant (simple seven-suture method with probe and cautery)	2	Died thirty-seventh day after operation Autopsy: Pelvic abscess, left ureter had abscess
				2/2/37: Right ureterointestinal trans- plant (simple seven-suture method with carrier); prostatoscinal-vesiculocystec- tomy, extraperitoneal		

TABLE IX—CONT'D

RESULTS, AUTOPSY FINDINGS

NO. OF STAGES

OPERATION

PREVIOUS TREATMENT IF ANY

INDICATION, OPERABILITY

SEX AGE

REFERENCE IF PREVIOUSLY REPORTED

W. C.⁶¹ 72 M Carcinoma of bladder, invading prostate; Inoperable; pelvis frozen 4/26/34: Bilateral ureterointestinal transplant (simple seven-suture method); prostateseminal-vesiculocystectomy; carcinoma found in perivesical region, not all removed

(Case 11)

J. V.⁶¹ 63 M Squamous carcinoma of bladder, invading prostate; Inoperable 6/11/34: Right ureterointestinal transplant (simple seven-suture method); left ureter ligated 8/1/34: Abdominal prostateseminal-vesiculocystectomy

(Case 7)

H. S.⁶¹ 63 M Carcinoma of bladder, recurrent; Operable 8/27/34: Bilateral ureterointestinal transplant (simple seven-suture method) 10/24/34: Abdominal retroprostato-seminal-vesiculocystectomy

(Case 10)

J. M.* 69 M Carcinoma of prostate; Inoperable None 9/11/34: Bilateral ureterointestinal transplant (seven-suture method) 10/24/34: Cystectomy only; prostate "frozen," in pelvis 10/31/35: Left ureterointestinal transplant (simple seven-suture method) 12/10/35: Right ureterointestinal and abdominal prostateseminal-vesiculocystectomy

L. P. B.⁶³ 54 M Carcinoma of bladder; Operable

1 Died eleventh day after operation
Autopsy: Acute pyelonephritis, local peritonitis, bronchopneumonia

2 Died fifteenth day after operation from obstruction of left ureter, abscess of left kidney, pelvic abscess

2 Died twenty-fourth day after operation; developed septicemia from pelvic abscess
Autopsy: Stenosis, ureteral orifices; *B. coli* septicemia; pelvic abscess

2 Died eleventh day after operation of bronchopneumonia, pelvic abscess; local metastases present; transplant in good condition (autopsy)

2 Alive and well 3 yr. after operation; postoperative pyelonephritis

R. R.*	M 58	Carcinoma of bladder Operable	None	11/26/37: Right ureterointestinal trans- plant (simple seven-suture method with carrier) 12/23/37: Left ureterointestinal trans- plant, same technique, abdominoperineal prostatoseminal-vesiculocystectomy	2	Died 10 days after operation Autopsy: Bronchopneumonia; transplant normal; peritoneum clean; wound clean
H. F.*	M 69	Carcinoma of prostate Operable	Supra- pubic cystos- tomy 2 wk. car- rier	11/30/37: Right ureterointestinal trans- plant (simple seven-suture method with carrier) 1/11/38: Left ureterointestinal trans- plant, same technique, abdominoperineal prostatoseminal-vesiculocystectomy	2	Died 8/16/38, 7 mo. after operation, car- cinomatosis
L. S.*	F 55	Carcinoma of bladder Operable	Fulgura- tions	6/4/38: Left ureterointestinal trans- plant (simple seven-suture method with carrier) 6/21/38: Right nephrostomy 7/12/38: Total cystectomy (abdominal) 8/8/38: Right nephrectomy.	2	Alive and well 6 mo. after operation
G. C. P.*	M 48	Carcinoma of bladder Operable	Fulgura- tion	11/18/38: Right ureterointestinal trans- plant (simple seven-suture method with carrier) 12/7/38: Left ureterointestinal trans- plant, same technique, with abdomino- perineal prostatoseminal-vesiculocystec- tomy	2	Alive and well 1 1/2 mo. after operation
E. G.*	F 47	Epidermoid carcinoma of vagina Operable	Fulgura- tion, x-ray	3/9/39: Left ureterointestinal trans- plant (seven-suture method with car- rier) 3/28/39: Right ureterointestinal trans- plant with abdominovaginal cystoure- threctomy	2	Course after operation uneventful

TABLE IX—CONT'D

RESULTS, AUTOPSY FINDINGS

TABLE LX							RESULTS, AUTOPSY FINDINGS
REFERENCE IF PRE- VIOUSLY REPORTED	SEX AGE	INDICATION, OPERABILITY	PREVIOUS TREATMENT IF ANY	OPERATION	NO. OF STAGES	RESULTS, AUTOPSY FINDINGS	
F. C.*	F 44	Carcinoma of bladder Operable	Fulgura- tion	12/7/36: Left nephrostomy 1/6/37: Right ureterointestinal trans- plant (simple seven-suture method with carrier) 2/3/37: Left ureterointestinal trans- plant, same technique; abdominal extra- peritoneal cystectomy	2	Alive 2 yr. after operation; has inci- sional hernia and suprapubic fistula	
N. V.*	M 55	Carcinoma of bladder, invading prostate Operable	Fulgura- tion	1/8/37: Left nephrostomy 2/5/37: Bilateral ureterointestinal transplant (simple seven-suture method with carrier) 3/10/37: Suprapubic prostatoseminal- vesiculocystectomy 2/17/37: Left ureterointestinal trans- plant (seven-suture method with car- rier) 3/15/37: Right ureterointestinal trans- plant, same technique; abdominal cys- tectomy 4/29/37: Left ureterointestinal trans- plant (simple seven-suture method with carrier) 5/13/37: Right ureterointestinal trans- abdominal urethrocytectomy 7/14/37: Left ureterointestinal trans- plant (simple seven-suture method with carrier) 8/20/37: Right ureter ligated, abdomi- noperineal prostatoseminal-vesiculocys- tectomy	2	Died just after operation Autopsy: Massive collapse of lung Alive and well 2 yr. after operation, working hard	
A. I.*	M 52	Carcinoma of bladder Operable	Fulgura- tion, x-ray therapy, radium		2	Died 1 yr. and 8 mo. after operation (12/27/38) Autopsy: Recurrence of tumor in pelvis and peritonitis; left kidney in good condition	
L. M.*	F 65	Squamous carcinoma of bladder Operable	Fulgura- tion		2	Died 9/16/38, 1 yr. after operation Autopsy: Carcinomatosis; both kidneys free from infection	
R. J.*	M 54	Carcinoma of bladder Inoperable	Fulgura- tion				

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dorsally, the easier becomes the perineal portion of the procedure. The abdominal wound is closed in layers without drainage (Fig. 3).

The patient is then placed in the usual position utilized in perineal prostatectomy. The prostate is exposed and an extracapsular dissection of the prostate is carried out (Fig. 4). The prostatic urethra is divided, the fascia overlying the seminal vesicles is opened, and this plane of cleavage meets the one developed from above. The prostate, seminal vesicles, and bladder are thereby removed perineally *en masse* (Fig. 5). Two wick drains and a tube drain are placed well up into the extraperitoneal space and the wound is closed (Fig. 6). This procedure ensures excellent dependent drainage of the extraperitoneal dead space.

SUMMARY

1. Total extirpation of the bladder is a feasible operation, particularly in the treatment of vesical cancer.
2. The history of the evolution of this operation is reviewed.
3. The indications for cystectomy are noted.
4. The various methods of diversion of the urinary stream are presented.
5. The technique of total removal of the bladder alone or with adjacent organs is described.
6. The results of total cystectomy are summarized.
7. Twenty-five personal cases are tabulated and analyzed.
8. The technique of abdominoperineal total prostatoseminal-vesiculocystectomy is presented.

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result after choledochoduodenostomy in forty-two patients, found that 88 per cent were made well from three to twelve years. Bernhard did fifty-eight choledochoduodenostomies with a survival time in two-thirds of the patients of more than fifteen years. DuBose¹² reported excellent clinical results in twenty-one cases. Wangersteen's⁶⁶ important contribution in 1928 presented the concept: "Probably only in the event of obstruction to the flow of bile through the new stoma does the potential infection in the bowel become a menace." Oettle⁴⁷ has a similar opinion and believes the anastomosis of the biliary tree to the gastrointestinal tract must be wide; that, in a wide anastomosis affording easy filling and emptying of the biliary passages, an infection never follows; and that the unhindered biliary drainage guarantees prompt elimination of invading bacteria as was shown experimentally by Radsiewsky in 1902. Eliason¹³ in 1936 concluded that ascending infection was a complication whose frequency was not great enough to discard the operation for "biliary intestinal anastomosis."

These clinical reports convinced us that we should be able to approximate them experimentally with adequate postoperative survival time to answer our experimental problem.

SURGICAL TECHNIQUE

A total of thirty-three dogs was used. The first procedures consisted of either cholecystojejunostomy or choledochojejunostomy after resection of the duodenum and seven-eighths of the stomach. Gastrointestinal continuity was restored by a Polya anastomosis, the gall bladder or the common duct being sutured to the jejunum. The gall bladder was abandoned early in this study, and in the first twenty animals the common duct was fastened by several fine sutures to the jejunum and then a purse-string suture was used to invaginate the bowel around the common duct. Despite satisfactory appearance when the operation was finished, none of these preparations survived long enough for a study of pernicious anemia. Most of the animals died immediately postoperatively from biliary leakage and peritonitis, or two to four months later from obstruction of the common duct.

Beginning with the twenty-first animal, a simpler technique was adopted. All suture material at the site where the common duct traversed the jejunum was eliminated. A small stab wound, about the size of the duct, was made in the jejunum. A single silk suture was inserted into the common duct about 0.5 cm. from the distal end which had been cut from the duodenum. Straight needles were threaded to each end of this suture. They were then inserted through the stab wound into the lumen of the jejunum and finally pushed through the bowel wall about 0.5 cm. apart, approximately 1.5 cm. from the stab wound. When these sutures were tied, the common duct was pulled about 1.5 cm. into the bowel lumen and the jejunum went up and around the duct (Figs.

CHOLEDOCHOJEJUNOSTOMY

AN EXPERIMENTAL STUDY AFTER RESECTION OF THE DUODENUM AND SEVEN-EIGHTHS OF THE STOMACH

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THIS report describes the findings in an experimental preparation following resection of the entire duodenum and seven-eighths of the stomach. This was done in order to determine whether such surgical intervention would produce pernicious anemia in dogs. The failure to alter the blood pictures has been reported.³

Resection of seven-eighths of the stomach and the entire duodenum necessitates transplantation of the biliary and pancreatic ducts. The pancreatic ducts may be dismissed as relatively unimportant, because in the dog it is almost impossible to keep these ducts from finding their way back into the bowel. The restoration of biliary drainage into the gastrointestinal tract without complicating liver infections seemed, after review of the literature, to be a surgical problem which might prevent a protracted investigation. Experimental reports were mostly discouraging, but Mann and Kawamura⁴¹ found that, after complete duodenectomy and choledochointerostomy, ten dogs had a survival time of 325 to 555 days. These investigators were interested primarily in whether or not the duodenum was an organ essential for life and, therefore, failed to describe the appearance of their choledochojunal anastomosis: they made little mention of the presence or absence of liver infection or damage, noting, however, that in some of their animals the common duct was not only dilated, but also markedly infected.

Gage,¹⁷ studying changes in the liver following cholecystogastrostomy and cholecystoduodenostomy, first studied forty normal dogs and found histopathologic liver changes in every case. These changes were small areas of necrosis of liver cells with round cell infiltration. These areas at times were rather extensive and in some instances simulated abscess formation. Perivascular infiltration was a common occurrence, but there were no changes in the walls or epithelial lining of the biliary ducts. Fifteen animals were studied fifteen days postoperatively and 53.3 per cent showed no increase in the inflammatory process as compared to normal livers. Seven, or 46.6 per cent, showed slight to moderate increase in pathologic findings when compared to normal livers.

The clinical reports were, however, a basis for assuming that the animal preparations contemplated by us should survive long enough to afford the data desired. Thus, Finsterer,¹⁴ reporting on the permanent

TABLE I
RESULTS

DOG NO.	POST-MORTEM TIME AFTER OPERATION	CAUSE OF DEATH	GASTRIC SECRETION		RED BLOOD CELL CHANGES	SIZE OF BILIARY TREE	GALL-BLADDER* HISTOLOGY	LIVER* HISTOLOGY
			ALCOHOL	HISTAMINE				
1	2½ yr.	Sacrificed	0	+	None	2.3 times normal	Minor	Minor
2	2½ yr.	Sacrificed	0	Very little	None	2.4 times normal	Minor	Minor
3	2 yr.	Central nervous infection	0	0	None	2.5 times normal	Negative	Negative
4	2 yr.	Central nervous infection	0	0	None	2.3 times normal	Negative	Negative
5	2 yr.	Sacrificed	0	0	None	1.4 times normal	Minor	Minor
6	2 yr.	Sacrificed	0	0	None	1.6 times normal	Minor	Negative
7	1½ yr.	Sacrificed	0	0	None	1.4 times normal	Minor	Negative

*For practical purposes the livers were normal histologically and the gall bladder showed no evidence of infection, there being no leucocytic or lymphocytic infiltration; some perilobular fibrosis was present.

which was patent and wide open in all cases; (4) no significant microscopic evidence of active gall-bladder infection (Figs. 9 and 10); (5) even though barium given by mouth to one animal visualized the gall bladder and biliary tree, there was no histologic evidence for liver in-

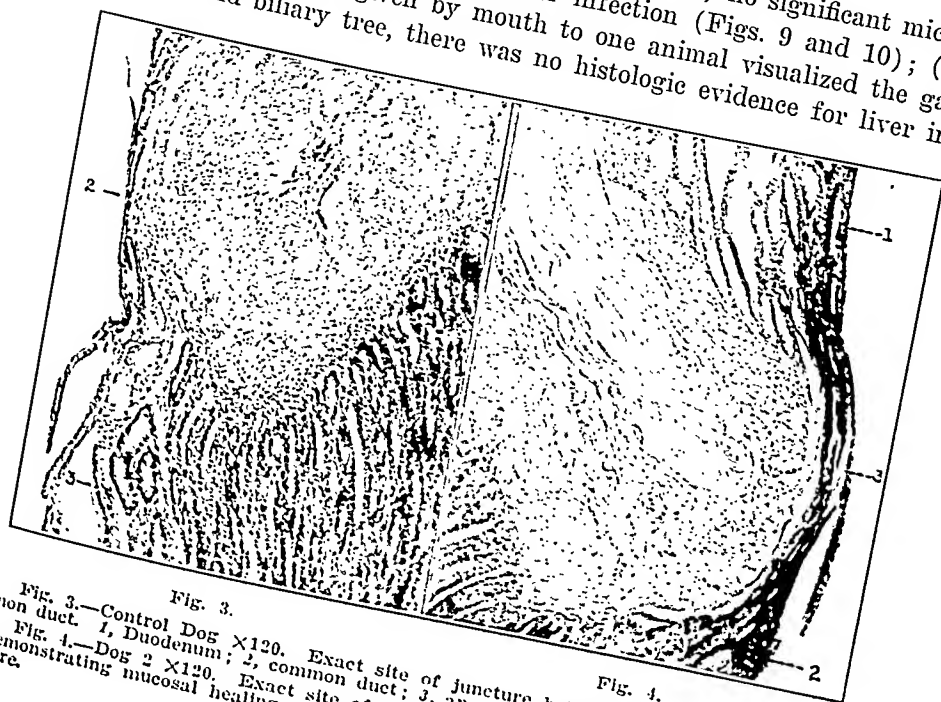


Fig. 3.

Fig. 4.

Fig. 3.—Control Dog X120. Exact site of juncture between duodenum and common duct. 1, Duodenum; 2, common duct; 3, anastomotic juncture.
Fig. 4.—Dog 2 X120. Exact site of juncture between jejunum and common duct demonstrating mucosal healing. 1, Common duct; 2, jejunum; 3, anastomotic juncture.

1 and 2). Immediately after Sept. 20, 1935, when this technique was adopted, the results improved. Seven of the next thirteen animals operated upon by this technique survived for from two to two and three-fourths years. The six deaths were secondary to the following: one animal eviscerated; one common duct pulled out and the animal died from biliary peritonitis; two animals died from peritonitis with the common duct appearing in satisfactory position; and one animal died from an unknown cause, the site of duct transplant appearing satisfactory.

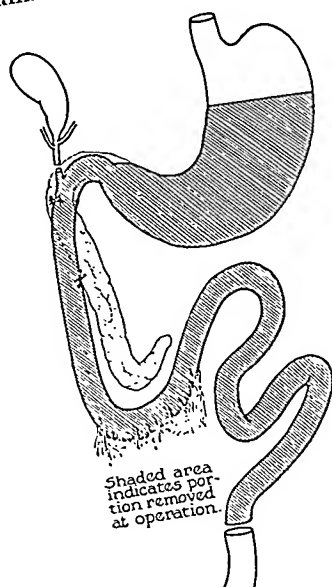


Fig. 1.

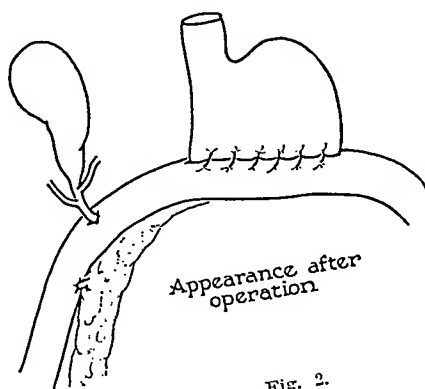


Fig. 2.

As previously reported, none of the animals developed pernicious anemia. They remained in excellent condition for two or more years, after which time three of the dogs died from an infection of the central nervous system which invaded our kennels, occurring not only in this series of animals but also in others not operated upon. The others were sacrificed.

RESULTS

Following modification of surgical technique, the operative mortality immediately decreased and seven out of thirteen animals survived for from two years to two years and nine months. The gall bladder and the biliary tree of one of the animals was visualized from barium given by mouth (Fig. 16).

The essential findings in this study, as shown in Table I, were: (1) the excellent condition of the animals throughout the study; (2) the persistence of a normal blood picture; (3) moderate dilatation of the biliary tree with no obstruction to the distal end of the common duct,

mucosa of the jejunum healing to the mucosa of the common duct without interposition of connective tissue (Figs. 4-6, and especially Figs. 7 and 8).



Fig. 9.

Fig. 10.

Fig. 9.—Dog 7 $\times 130$. Gall bladder. Practically no dilatation of biliary tree. No histologic evidence of infection.

Fig. 10.—Dog 2 $\times 130$. Gall bladder. Showing little or no inflammatory changes despite marked dilatation of the common duct.

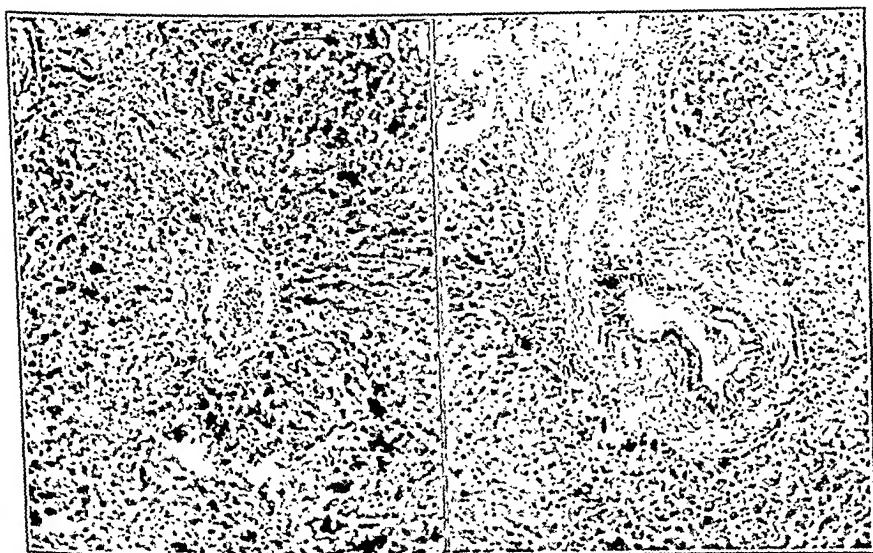


Fig. 11.

Fig. 12.

Fig. 11.—Dog 3 $\times 130$. Liver. Liver lobule with central vein. Essentially normal despite finding of barium in the gall bladder.

Fig. 12.—Dog 3 $\times 130$. Liver. Periportal area showing little or no inflammatory changes despite finding of barium in gall bladder.

fection or liver damage more than is normal for adult dogs (Figs. 11-14, 16); (6) serial section taken every 10 μ through the site where the common duct entered the jejunum showed mucosal healing, the

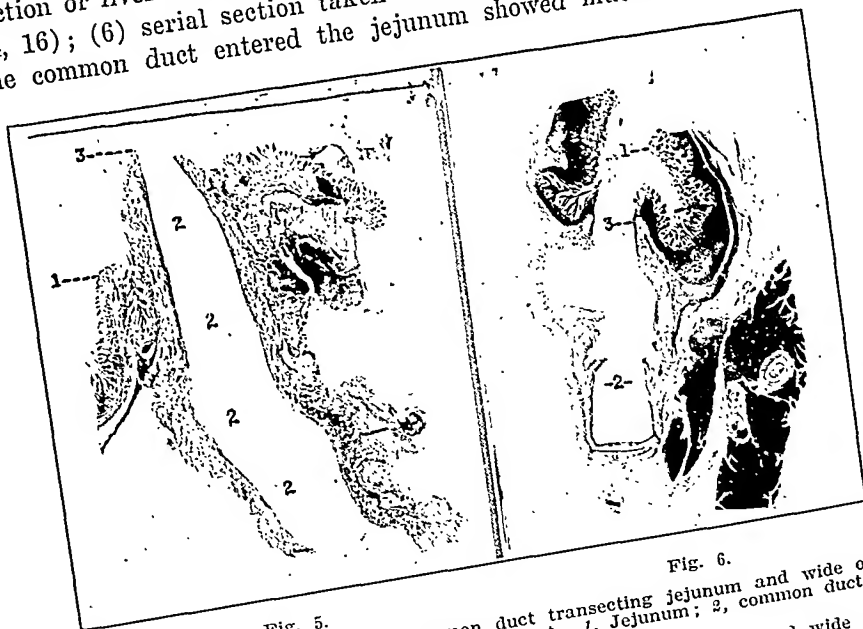


Fig. 5.

Fig. 5.—Dog 6 $\times 5$. Showing common duct transecting jejunum and wide open orifice. Moderate dilatation of the common duct. 1, Jejunum; 2, common duct; 3, anastomotic junction.

Fig. 6.—Dog 2 $\times 4$. Showing common duct transecting jejunum and wide open orifice. Considerable dilatation of the common duct. 1, Jejunum; 2, common duct; 3, anastomotic junction.



Fig. 7.

Fig. 7.—Dog 1 $\times 65$. Showing mucosal union between jejunum and common duct. Least satisfactory of all animals. 1, Jejunum; 2, common duct; 3, anastomotic junction.

Fig. 8.—Dog 3 $\times 60$. Showing mucosal union between jejunum and common duct. 1, Jejunum; 2, common duct; 3, anastomotic junction.

DISCUSSION

The surgical concept that liver infection is reduced by transplanting biliary ducts to the stomach so that the anastomotic site will be exposed to invasion by acid media believed less septic is not substantiated by these results. The site of anastomosis apparently does not affect the problem of ascending liver infection. This was shown by Sandblom, Bergh, and Ivy³⁶ and Gentile²⁰ in that both groups of investigators consistently found infected livers despite the fact that Ivy and associates anastomosed the gall bladder to the duodenum after pyloric exclusion and Gentile used the stomach after gastric resection and Polya-Balfour anastomosis.



Fig. 16.—Roentgenogram of Dog 3. Showing barium in gall bladder and biliary ducts.

Inasmuch as both hypoacidity and common duct infection were present in our animals, another explanation must be presented for the negligible liver pathology. Our results in confirmation of Wangenstein⁶⁰ suggest that the site of anastomosis is not of major importance, but that



Fig. 13.

Fig. 14.

Fig. 13.—Dog 2 $\times 130$. Liver. Animal had marked dilatation of common duct but liver and periportal areas are essentially normal for dog of this age.

Fig. 14.—Dog 7 $\times 130$. Liver. Periportal area which is essentially normal. No evidence of inflammation.

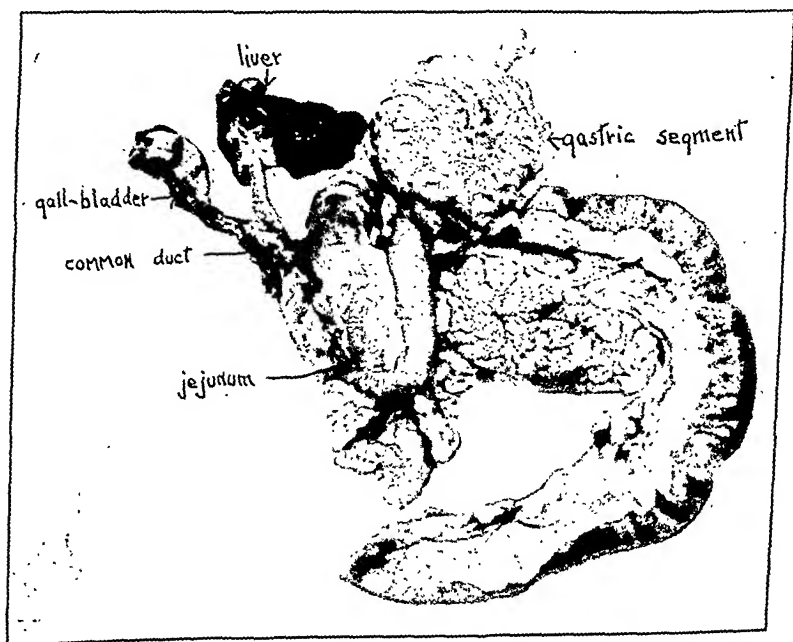


Fig. 15.—Dog 5. Autopsy specimen. Showing little or no dilatation of the biliary tree and very small residual gastric segment.

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its size is. If the anastomotic opening of the biliary tree to the gastrointestinal tract remains persistently patent with a sufficiently large orifice giving adequate drainage, there follows a minimum of stasis with limited ascending infection and little or no liver pathology.

The dilatation of the biliary tree in this series of animals despite patent anastomotic openings would be disturbing but for Branch, Orville and Zollinger,⁶ who showed that instrumental dilatation of the papilla of Vater will lead to temporary obstruction and dilatation of the biliary tree. May we not assume that the postoperative inflammatory reaction around the common ducts in our animals led to a temporary biliary obstruction causing dilatation much the same as the instrumental dilatation described by Branch and co-workers?

CONCLUSIONS

1. In the dog, choledochojunostomy is feasible after gastric and duodenal resection.
2. Such animals remain in excellent condition for as long as two and three-fourths years.
3. Pernicious anemia does not develop.
4. Modification of the technique used for choledochojunal anastomosis in our animals was followed by: (a) reduction in postoperative mortality; (b) decreased incidence of common duct obstruction; (c) choledochojunal anastomosis with mucosal healing, having practically no scar or stenosis from connective tissue formation; and (d) histologic evidence of minimum gall-bladder and liver infection with histologic changes not exceeding normal for adult dogs.

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THE EFFECT OF GALL-BLADDER DISEASE ON THE ELECTROCARDIOGRAM

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ATTEMPTS to answer the question—Can a diseased gall bladder cause myocardial degeneration?—have been productive of diverse opinions in the literature.* These multiple reports and statements on the relation of gall-bladder disease to heart disease are extremely difficult to evaluate clinically. In those reports, for instance, of the presumed cure of angina pectoris following the removal of a diseased gall bladder, it is impossible to exclude the probability that the disappearance of the attacks was merely the result of a spontaneous remission in the course of the angina pectoris. Possibly the pain was not cardiac in origin but was referred from the diseased gall bladder to the heart.

Recently, Fitz-Hugh, Jr., and Wolferth¹ reported reversible electrocardiographic changes in six patients with gallstones who were surgically treated. These patients all exhibited cardiac symptoms, chiefly anginoid effort types, and all were found to have abnormal electrocardiographic tracings, chiefly flat or inverted T-waves in the first two leads. In all the cases clinical symptoms were benefited and there was a return toward normal of the electrocardiographic deviations within a few weeks to a few months after the surgical removal of the gallstones.

The significance of their electrocardiographic observations is evident. If a diseased gall bladder can produce an abnormal tracing, a more critical clinical application of electrocardiographic deviations must be applied. We determined to repeat their studies. Accordingly electrocardiograms were made before and after surgery on patients with gall-bladder disease. Twenty-one patients underwent surgery. All had chronic cholecystitis with cholelithiasis. There was only one male patient. The ages ranged from 21 to 68 years. Six patients had essential hypertension as evidenced by a persistent elevation of the blood pressure. Only two of this group had roentgenologic evidence of cardiac enlargement. One patient with cardiac enlargement but a blood pressure of 148/84 was likewise considered to have hypertensive heart disease. None of the other etiologic types of heart disease was encountered. Chest pain at all significant of angina pectoris was not complained of by any of the patients. Only one patient gave a history of severe dyspnea on mild exertion and she had hypertensive heart disease.

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*No attempt is made to list all the literature. This has been done by numerous authors. See Laird, S. M.: Brit. M. J. 1: 584, 1938.

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disease was an abnormal electrocardiogram, which tracing became normal after the removal of gallstones and a diseased gall bladder.

The electrocardiograms of one of these patients which were made five days before a cholecystectomy was performed are shown in Fig. 1*A*. The T-wave in Lead II is inverted. The tracings shown in Fig. 1*B* were made eight days after the operation. The T-wave in Lead II is now upright and has remained normal in repeated examinations. This patient was a white woman, 40 years of age.

The electrocardiograms of the other case, a 53-year-old white woman, made eight days preoperatively show (Fig. 2*A*) in Lead II depression of the S-T interval with the T-wave inverted and of low voltage. The tracings made six days postoperatively (Fig. 2*B*) are normal.

COMMENT

As noted by Fitz-Hugh and Wolferth, the electrocardiographic deviations consisted for the most part of T-wave changes in significant leads. Slurring and notching of the QRS complexes, marked elevation or depression of the S-T interval or coronary occlusion types of T-waves were not noted.

The answer to the question—Can a diseased gall bladder cause myocardial degeneration?—must await pathologic study. The present report merely confirms that of Fitz-Hugh and Wolferth that gall-bladder disease per se can produce abnormal electrocardiograms which revert to normal after surgical amelioration of the gall-bladder disease. The practical application of these observations in regard to the interpretation of T-wave changes in electrocardiograms is evident.

The rapid reversal to normal in the cases cited above would indicate a toxic effect on the myocardium of the diseased gall bladder.

There was no correlation between the clinical and pathologic severity of the gall-bladder disease and the T-wave changes. Normal records were obtained in patients with the worst pathologic gall bladders.

SUMMARY

1. Gall-bladder disease may produce abnormal T-wave changes in the electrocardiogram.
2. After removal of the diseased gall bladder, the electrocardiogram can become normal.
3. There is no correlation between the clinical and pathologic severity of the gall-bladder disease and the electrocardiographic abnormalities.

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Significant abnormal preoperative electrocardiograms were found in four cases. Three had electrocardiograms which became normal from six to eight days after operation. One of these three patients had hypertensive heart disease so that her preoperative records may have been transiently abnormal as occasionally occurs in hypertensive individuals. The one case that showed no change after operation had hypertensive heart disease. There remain two patients whose only evidence of heart

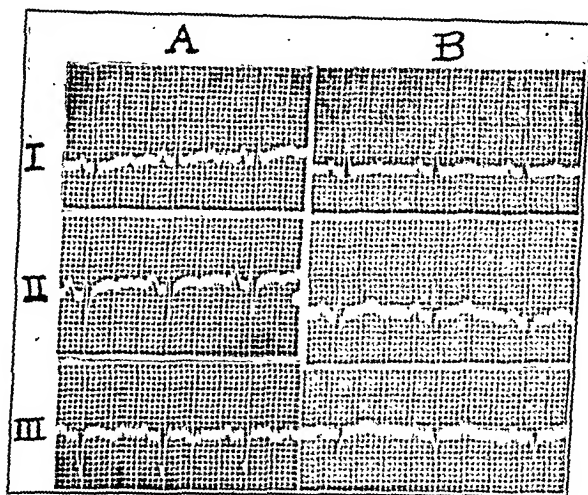


Fig. 1.—Electrocardiograms of Mrs. C., white, aged 40 years. *A*, made five days before cholecystectomy, show T-wave inverted in Lead II. *B*, made eight days postoperatively, show no abnormalities.

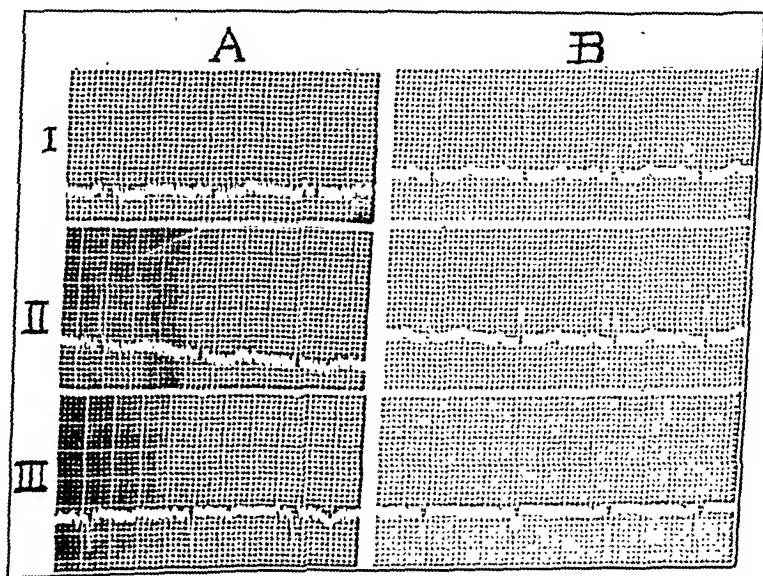


Fig. 2.—Electrocardiograms of Mrs. R., white, aged 53 years. *A*, made eight days before cholecystectomy, shows depression of S-T interval and T-wave inversion in Lead II. *B*, made six days postoperatively, are normal.

RESULTS

The results of the experiments are shown in Table I. All designations of plasma prothrombin are in percentages of the preoperative value. In all but two experiments there was an immediate fall in plasma prothrombin to an average of 71 per cent of the preoperative level. During the ensuing twenty-four hours, the level remained in the neighborhood of 70 per cent. Subsequently, sometime between the forty-eighth and one hundred and forty-fourth postoperative hour, a return to the preoperative level occurred. Experiments 6 and 7 were performed on the same animal on different occasions. On one of those occasions there was a slight rise in plasma prothrombin after trauma to the liver, while in the other a significant fall occurred, although its appearance was slightly delayed.

Fig. 1 shows in a solid line a composite curve of the seven experiments in which the liver was traumatized. The average fall in plasma prothrombin following trauma to the liver was to 75 per cent of the original level, and six days elapsed before the plasma prothrombin returned to the preoperative level.

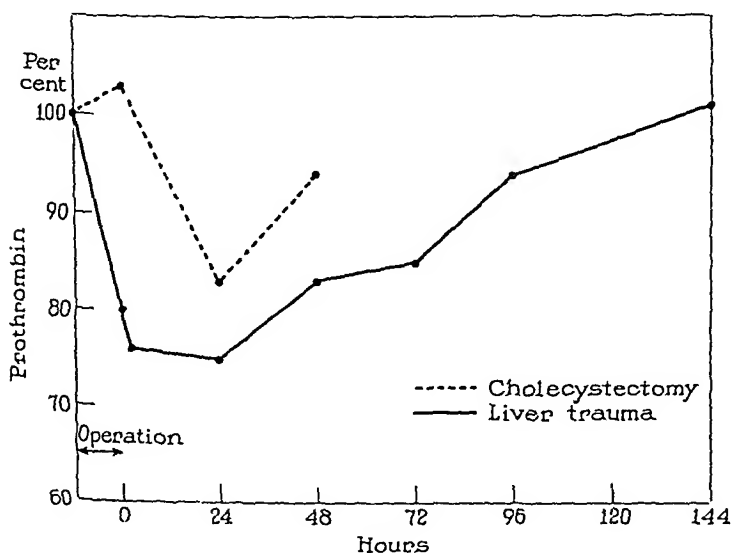


Fig. 1.

The broken line in Fig. 1 shows the average values for the plasma prothrombin of two dogs which were subjected to a cholecystectomy and ligation and division of the common bile duct. Although the liver was handled as little and as gently as possible, a 15 and 20 per cent fall in plasma prothrombin occurred at the end of twenty-four hours, with a partial return to normal in forty-eight hours. Simple laparotomy with the peritoneal cavity exposed for twenty-five minutes resulted in no change in the plasma prothrombin. Likewise, operations of the magni-

THE EFFECT OF TRAUMA TO THE LIVER ON THE PLASMA PROTHROMBIN*

AN EXPERIMENTAL STUDY

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THAT an operative procedure is a significant factor in the production of the hemorrhagic tendency associated with jaundice is indicated by the fact that the overwhelming majority of patients who bleed do so after operation. The underlying defect which is responsible for the hemorrhage in jaundice is a deficiency of plasma prothrombin, and a number of observations indicate that the liver is intimately concerned in the maintenance of the normal level of this substance. Smith, Warner, and Brinkhous¹ have shown that a precipitous fall in plasma prothrombin occurred in hepatic damage incident to chloroform anesthesia in dogs, and Warner,² after removing approximately 65 per cent of the liver of the rat, demonstrated a fall in plasma prothrombin which returned to normal in about two and one-half weeks. Andrus, Lord, and Moore³ have shown that total removal of the liver in dogs was followed by a fall in plasma prothrombin to less than 20 per cent of normal within ten hours.

Since, during most operative procedures on the biliary tract, mechanical trauma to the liver is unavoidable, it has seemed important to study experimentally the level of plasma prothrombin following mechanical trauma to the liver.

METHODS

Normal healthy dogs weighing between 25 and 40 pounds were selected for the operative procedures. Intravenous nembutal anesthesia was employed. Plasma prothrombin was determined by the method of Warner, Brinkhous, and Smith.⁴ Each animal was anesthetized, and under aseptic precautions the peritoneal cavity was opened through an upper right rectus incision. The various lobes of the liver were then gently massaged between the fingers and thumb for twenty-five minutes. The massage was not sufficiently severe to cause either tearing of the capsule or hemorrhage. The abdomen was then closed in layers. Blood samples for the determination of plasma prothrombin were drawn before the operation, at the cessation of trauma to the liver, two hours postoperatively, and at suitable periods thereafter. The general postoperative behavior of the dogs was in no way different from that of animals subjected to a simple exploratory laparotomy.

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THE EFFECT OF HEPATECTOMY ON THE PLASMA PROTHROMBIN AND THE UTILIZATION OF VITAMIN K*

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CERTAIN EXPERIMENTAL work has suggested that the liver may be the essential organ in the maintenance of the level of the plasma prothrombin. Thus, in 1937, Smith, Warner, and Brinkhous¹ showed that hepatic damage caused by prolonged chloroform anesthesia was followed by a significant fall in plasma prothrombin and that about a week elapsed before the normal level was regained. Warner² noted a similar decrease of the plasma prothrombin after removal of about 65 per cent of the liver of the rat, with a return to normal in about 2½ weeks. And finally Lord³ recently has shown that even gentle massage of the liver over a period of twenty-five minutes produces a fall of 25 per cent in the plasma prothrombin level which is recovered from after 6 days.

Extending this work, we have performed complete hepatectomy in six dogs using the techniques of Mann⁴ and of Markowitz, Yater, and Burrows.⁵ This was followed by a precipitate fall in the plasma prothrombin of 45 per cent within one hour after operation which continued until by eight or ten hours it had reached 20 per cent of normal or lower (Table I). In two animals which survived longer than ten hours the plasma prothrombin fell to 5 per cent of normal. At autopsy, petechiae and ecchymoses were noted as early as 11 hours after hepatectomy.

TABLE I

TYPE OF EXPERIMENT	PLASMA PROTHROMBIN IN PERCENTAGE OF NORMAL AT HOURS INDICATED					
	0	1	5½	7½	9	10
I. Instillation of vitamin K	23*	19	29	37	44	47
II. Hepatectomy	100	57	38	20	17	14
III. Hepatectomy and instillation of vitamin K	100	54	32	22	17	15

*Each figure is the average of two experiments.

Contributing to the abrupt initial fall in the plasma prothrombin may be the factor of trauma to the liver incident to the operation, but the

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tude of a reverse Eck fistula⁵ and a gastroenterostomy caused no fall in the plasma prothrombin.

Four dogs subjected to massage of the spleen and kidney have shown an average fall in plasma prothrombin to 75 per cent of the preoperative

TABLE I
PLASMA PROTHROMBIN FOLLOWING TRAUMA TO THE LIVER

EXPERIMENT NO.	DOG NO.	PRE-OPERATIVELY	AT END OF TRAUMA	PLASMA PROTHROMBIN HOURS POSTOPERATIVELY					
				2	24	48	72	96	120
1	454	100%	66%	70%	64%	101%	84%		
2	454	100%	66%	61%	64%	90%			
3	271	100%	80%	76%	75%	78%	85%	91%	
4	P-21	100%	73%	70%	80%	73%	69%	97%	
5	P-22	100%	72%	70%	67%	95%			
6	P-19	100%	103%	108%	77%	73%	72%		81%
7	P-19	100%	99%	79%	73%	83%	85%	94%	
Average		100%	80%	76%	75%				

level within twenty-four hours. In contrast to the recovery period of six days after massage of the liver, the plasma prothrombin after massage of the spleen and kidney returned to the preoperative level within forty-eight hours. From these findings it is evident that general tissue injury is followed by a prompt and significant fall in plasma prothrombin and that this fall is not peculiar to liver injury. However, the marked difference in the rate of recovery of the plasma prothrombin is further evidence that the liver is more intimately concerned in the elaboration of plasma prothrombin than is the spleen or kidney.

SUMMARY

The results indicate that trauma to the liver, such as might be necessary in difficult operations on the biliary tract, causes a profound decrease of the plasma prothrombin. Since the majority of patients with jaundice already have a decreased plasma prothrombin, such a postoperative fall may depress the prothrombin to the bleeding level of about 20 per cent. It is probable that these observations offer one explanation of the fact that the hemorrhage in jaundiced patients, when it occurs, does so after an operative procedure.

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THE IMPERMEABILITY OF THE VIABLE OBSTRUCTED BOWEL OF DOGS TO *CLOSTRIDIUM BOTULINUM* TOXIN*

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THE absorption of toxic substances from the obstructed bowel is believed, by some investigators, to be the significant factor in producing death in intestinal obstructions. It would appear, however, that absorption of substances to which the normal bowel is permeable, via the mesenteric veins, is retarded in bowel obstruction as shown by Wangensteen and his associates.^{3, 5} An increased rate of absorption via the mesenteric lymphatic channels was observed by Sperling and Wangensteen,⁶ but this factor did not appear to be reflected in the mortality after division of the mesenteric lymphatic pedicle. Increase of intraluminal pressure which impairs the viability of the bowel, thus leading to greater mural permeability and opening up a new avenue of absorption, the transperitoneal, was believed by Wangensteen⁸ to be the important agency in the cause of death in experimental ileal obstructions and in low obstructions in man.

Haerem, Dack, and Dragstedt¹ injected *Clostridium botulinum* toxin into closed intestinal loops of dogs and reported that abnormal absorption could be demonstrated in the blood of such animals, while no evidence of absorption was obtained from the bowel of normal animals. In the light of recent denials of increased absorption in viable intestinal loops in bowel obstructions, the observations of Haerem and her associates have more than ordinary significance. Their experiments suggest that the viable obstructed bowel may be permeable to substances to which the bowel wall is normally impermeable.

The following experiments were undertaken to investigate the extent and manner of absorption of botulinum toxin in experimental intestinal obstructions as reported by Haerem and her associates.

METHOD

The following experiments were devised to establish the permeability of the normal dog bowel wall to *Clostridium botulinum* toxin: (1) the toxicity of dog's blood after intravenous toxin administration; (2) the

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greater decrease and its continuance would seem to be directly connected with the absence of this organ.

It is now well recognized that, in the absence of hepatic damage, an animal or patient with a lowered plasma prothrombin responds to the administration of vitamin K and bile salts by a rise in the level of the prothrombin of the plasma within a few hours. Thus, in two of our animals whose plasma prothrombin had become markedly decreased because of long-standing biliary fistulas, the instillation of 10,000 units of vitamin K and 2 gm. of bile salts into the duodenum was followed by a rise of the plasma prothrombin as determined by the method of Warner, Brinkhous, and Smith⁶ from the level of 23 per cent to 47 per cent in ten hours.

To study the effect of hepatectomy on the utilization of vitamin K, two animals of this series whose livers were removed received similar instillations of 10,000 units of vitamin K (Klotogen) and 2 gm. of bile salts (bilein) into the duodenum at operation, but this failed to alter the typical curve of decrease in the plasma prothrombin level seen in hepatectomized dogs without such medication.

SUMMARY

The precipitate and continuous fall in the plasma prothrombin which follows hepatectomy is evidence that the liver, under normal conditions, is concerned in the continuous formation of prothrombin. Further evidence that the liver is the organ which, in the presence of vitamin K, forms prothrombin is found in the fact that instillation of a large amount of this vitamin during operation fails to alter the typical curve of decrease in the plasma prothrombin after hepatectomy.

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of blood and peritoneal fluid obtained at intervals of 2, 7, 11, and 14 hours after intubation were mouse tested and found to be nontoxic. Twenty-four hours after intubation, the dog was sacrificed by intravenous injection of 5 c.c. ether, and the contents of the stomach, jejunum, and ileum were Berkefeld-filtered and mouse-tested. These mice succumbed in 30 to 36 hours (No. 3, Table I).

TABLE I

TOXICITY FOR MICE OF BLOOD AND PERITONEAL FLUIDS OF DOGS INJECTED WITH *Cl. botulinum* TOXIN BY VARIOUS ROUTES

NO. ROUTE OF TOXIN ADMINISTRATION	TIME AFTER TOXIN ADMINISTRATION*	TOXICITY OF BLOOD†	TOXICITY OF PERITONEAL FLUID	EFFECT ON DOG
1 Stomach tube	Control	0 0		No effect
	2 hr.	0 0		
	7 hr.	0 0		
	10 hr.	0 0		
	20 hr.	0 0		
2 Stomach tube	Control	0 0	0 0	No effect
	2 hr.	0 0	0 0	
	6 hr.	0 0	0 0	
	10 hr.	0 0	0 0	
	14 hr.	0 0	0 0	
	24 hr.	0 0	0 0	
3 Stomach tube	Control	0 0	0 0	Sacrificed 24 hr. after intubation
	2 hr.	0 0	0 0	
	7 hr.	0 0	0 0	
	11 hr.	0 0	0 0	
	14 hr.	0 0	0 0	
Post-mortem gastrointestinal contents nonspecific for toxin				
4 Mesenteric vein	Control	0 0		Died 35 hr. after injection
	2 hr.	+ +		
	5 hr.	+ +		
	8 hr.	+ +		
5 Leg vein	Control	0 0		Died 11 to 12 hr. after injection
	1 hr.	+ +		
	3 hr.	+ +		
	7 hr.	+ +		
6 Leg vein	Control	0 0	0 0	Died 18 to 20 hr. after injection
	2 hr.	+ +	?	
	6 hr.	+ +	+ +	
	10 hr.	+ +	+ +	
	14 hr.	+ +	+ +	
7 Intraperitoneal	Control	0 0		Died 15 hr. after injection
	4 hr.	+ +		
	8 hr.	+ +		
	11 hr.	+ +		
8 Normal Biebl loop	Control	0 0		No effect
	2 hr.	0 0		
	6 hr.	0 0		
	8 hr.	0 0		
	20 hr.	0 0		
9 Closed jejunal loop (Biebl)	Control	0 0	0 0	Died 16 hr. after injection
	8 hr.	0 0	0 0	
Intraluminal pressure, 48 cm. water; hemorrhagic necrosis of loop at autopsy				

*Samples aspirated before toxin administration are designated "control."

† +, death of mouse; 0, mouse alive.

passage of the toxin into the peritoneal fluid after intravenous administration; (3) the passage of toxin into the blood after intraperitoneal administration, and (4) the impermeability of the normal Biebl loop to the toxin.

In all the experiments dogs were used. The presence of botulinum toxin was determined by the presence or absence of intoxication of mice. All injections of blood, peritoneal fluid, Berkefeld-filtered intestinal contents, or toxin into mice were of 0.2 c.c. quantities, measured in a 1 c.c. tuberculin syringe fitted with a 25 gauge needle, injected intraperitoneally into mice weighing 20 to 25 gm., in each instance in duplicate. Before the toxin was used in any experiment, its potency was determined by injection as described, the time being noted when the mice died. In each experiment, the potency test was performed; thus, "mouse potency, 2 hours" would indicate that duplicate mice injected intraperitoneally with 0.2 c.c. toxin died two hours after the injection.

All surgery was performed with surgical asepsis under intravenous pentobarbital sodium anesthesia (35 mg./kg.). Where peritoneal fluid samples were to be obtained, preliminary omentectomy was performed twenty-four hours before to facilitate free drainage of peritoneal fluid through a catheter with multiple perforations sutured to the anterior parietal peritoneum and emerging from the abdomen through a stab wound.

The closed jejunal loops in the dogs were made according to a method modified from Stone, Bernheim, and Whipple,⁷ the proximal closed end in every case being about 5 to 10 cm. distal to the ligament of Treitz, and the distal closed end being at a variable distance from it, the exact length being stated in each protocol. All injections into the bowel were made at least twenty-four hours after the particular segment had been brought to the outside of the abdomen and covered with skin, the familiar Biebl loop, which has the appearance of a satchel handle on the abdomen. Each dog equipped with a peritoneal catheter was dressed in a canvas vest through which the forelegs were placed and which was laced along the animal's back.

EXPERIMENT 1.—Mouse potency, 2 hours. A small dog was given 20 c.c. of toxin by stomach tube with no symptoms of intoxication appearing at any time. The animal's peripheral venous blood aspirated at 3, 7, 10, and 20 hours after intubation was not toxic for mice (No. 1, Table I).

EXPERIMENT 2.—Mouse potency, 1 hour, 45 minutes. The control blood and peritoneal fluid of a previously omentectomized medium sized dog were not toxic for mice. Forty cubic centimeters of the toxin were then administered to the dog by stomach tube, and postinjection samples of blood and peritoneal fluid obtained at intervals of 2, 6, 10, 14, and 24 hours were mouse-tested and were found to be nontoxic (No. 2, Table I).

EXPERIMENT 3.—Mouse potency, 2½ hours. The control blood and peritoneal fluid of a previously omentectomized small dog were not toxic for mice. Twenty cubic centimeters of toxin were then administered by stomach tube and samples

the following experiments the permeability of the closed loop wall to botulinum toxin was studied in relation to the intraluminal pressure which was determined directly by a needle inserted directly into the Biebl loop and measured by the level of a sustained single fluid column.

EXPERIMENT 9.—A 45 cm. closed jejunal loop was constructed in a medium-sized dog. A Biebl loop was made of the midportion of this; omentectomy was performed and peritoneal drainage established. Twenty-four hours later the pressure in the loop was 48 cm. water and samples of blood and peritoneal fluid were mouse-tested as controls and found to be negative. One hundred and five cubic centimeters of fluid intestinal contents were aspirated from and 5 c.c. botulinum toxin (mouse potency, 2 hours) injected into the Biebl loop. Peritoneal fluid and blood obtained from the dog 8 hours later were innocuous for mice. The dog died 40 hours after operation (16 hours after toxin injection). The autopsy showed the obstructed loop to have undergone hemorrhagic necrosis, with areas of gangrene being most prominent along the antimesenteric border (No. 9, Table I).

This experiment shows that botulinum toxin is not absorbed from obstructed loops directly into the general circulation nor into the peritoneum even at 48 cm. water pressure. The rapid rise of pressure in obstructed loops of the upper reaches of the gut, as compared with low intestinal loops, has been explained by Morton and Sullivan² as probably being due to increased secretion. Sperling⁴ found that in a dog intracolonic pressure of 30 cm. water sustained for 24 hours caused hemorrhagic damage to the wall; at 50 cm. water pressure, perforation occurred. Damage from distention, therefore, is to be reckoned with seriously. In Experiment 9, therefore, the final samples of blood and peritoneal fluid were taken just before seepage, perforation, and peritoneal contamination had occurred.

EXPERIMENT 10.—A large dog was prepared with a Biebl loop of closed jejunum and peritoneal catheter exactly as in Experiment 9. Twenty-four hours later the intrajejunal pressure was 37 cm. water, when blood and peritoneal fluid were found to contain no toxin. The unfiltered loop contents killed mice in 4 to 10 hours. Five cubic centimeters botulinum toxin (mouse potency, 1½ hours) were injected directly into the loop, and samples of blood, peritoneal fluid, and unfiltered loop contents were mouse tested at 2 hours and 11½ hours after toxin administration. No toxin was demonstrated in the 2-hour samples of blood and peritoneal fluid; the unfiltered intestinal contents killed the mice rapidly. The 11½-hour blood, peritoneal fluid, and intestinal contents rapidly killed mice. The dog died 36 hours after operation with hemorrhagic necrosis of the isolated loop (No. 10, Table I).

EXPERIMENT 11.—A small dog was prepared exactly as in Experiments 9 and 10, except that the closed loop was 35 cm. in length and the original contents of the loop were removed by brief perfusion with warm water. Twenty-four hours later the intrajejunal pressure was 30 cm. water, when blood, peritoneal fluid, and Berkefeld-filtered loop contents were negative on mouse test. Three and one-quarter cubic centimeters botulinum toxin (mouse potency 1½ hours) were injected directly into the Biebl loop, and samples of blood, peritoneal fluid, and Berkefeld-

The first three control experiments would indicate that dogs are unharmed by botulinum toxin given by mouth, the blood and peritoneal fluid being free of demonstrable toxin. If any toxin was present in the intestinal contents of these animals the following day, it was too small to be detected by the mouse test.

EXPERIMENT 4.—Mouse potency, 3 hours. The control blood of a small dog was nontoxic for mice. A mesenteric vein was then carefully packed off and a No. 25 gauge hypodermic needle inserted into the vessel and directed toward the root of the mesentery. A syringe containing 4 c.c. of toxin was carefully attached and the toxin was slowly injected. There was no contamination of the peritoneum with toxin or mesenteric blood. The abdomen was then closed and samples of peripheral blood obtained at 2, 5 and 8 hours after the mesenteric injection were mouse-tested; these mice died within a few hours of botulinum intoxication. The dog died of intoxication 35 hours after laparotomy (No. 4, Table I).

EXPERIMENT 5.—Mouse potency, $2\frac{1}{2}$ hours. After aspirating a sample of peripheral venous blood as control, 5 c.c. of toxin were injected intravenously into a medium-sized dog and blood samples were aspirated for mouse testing at intervals of 1, 3, 7 and 10 hours after the injection, and found to be lethal. Death of the dog occurred 11 to 12 hours after toxin administration (No. 5, Table I).

Control Experiments 5 and 6 confirm the lethal effect of the toxin on the dog when entrance into the blood stream has been gained.

EXPERIMENT 6.—Mouse potency, $2\frac{1}{2}$ hours. Six cubic centimeters of toxin were injected intravenously into a previously omentectomized medium-sized dog whose blood and peritoneal fluid obtained before injection were negative by mouse test. Samples of blood and peritoneal fluid were mouse tested 2, 6, 10, and 14 hours after administration of the toxin. All the postinjection blood samples contained toxin. The 2-hour peritoneal fluid sample, however, had its lethal effect on the mice delayed for 20 to 30 hours, while the 6, 10, and 14 hour samples killed the mice in 8 to 16 hours. The dog died 18 to 20 hours after toxin administration (No. 6, Table I).

Control Experiment 6 would indicate that the blood and peritoneal fluid are in chemical equilibrium as regards intravenously injected toxin. This is also demonstrated in Experiment 7.

EXPERIMENT 7.—Mouse potency, $2\frac{1}{2}$ hours. The control blood sample from a small dog was innocuous for mice. Twenty cubic centimeters toxin were injected intraperitoneally and blood samples aspirated at 4, 8, and 11 hours after administration of the toxin. These were all mouse-positive. The blood obtained 4 hours after toxin injection killed mice in three hours. Death of the dog occurred in 15 hours (No. 7, Table I).

EXPERIMENT 8.—Mouse potency, $1\frac{1}{2}$ to 2 hours. The control blood from a large dog with a high, unobstructed jejunal Biehl loop was negative by mouse test. Twenty-five cubic centimeters of toxin were injected into the lumen of the loop. Blood samples were aspirated at 2, 6, 8, and 20 hours and found to be non-toxic for mice (No. 8, Table I).

Control Experiment 8 shows that toxin is not demonstrable in dog's blood by the mouse method after injection directly into the jejunum. In

12, Table 11). Toxin was not present in demonstrable quantities in the dog's blood or peritoneal fluid at any time and was found to disappear from the lumen of the loop between 12 and 24 hours.

The cultures in Experiment 12 showed that it is usually possible to obtain sterile blood from the dog but that the peritoneal fluid aspirated is contaminated with *Staphylococcus albus* and other bacteria. The mice which died after injection of filtered intestinal contents showed the presence in both the heart and blood and peritoneal fluid of staphylococci, streptococci, and *Bacillus coli*.

DISCUSSION

These experiments support the evidence already at hand that an intestinal toxin absorbed directly into the mural circulation is not the agency responsible for deaths from bowel obstruction. No evidence of mesenteric absorption of the toxin injected into the closed loops was obtained. In closed distended intestinal loops, where the mural venous and capillary flow is obstructed through the agency of increased intraluminal pressure, the anoxic effect on the bowel wall results in transperitoneal migration of noxious substances.

CONCLUSIONS

1. *Cl. botulinum* toxin cannot be demonstrated in the blood or peritoneal fluid after its administration by stomach tube to the normal dog, although the toxin can be demonstrated in the intestine. The dog tolerates well *Cl. botulinum* toxin so administered or injected directly into the intestine.
2. Intravenous injection of small amounts of *Cl. botulinum* toxin is lethal for a dog. The blood and peritoneal fluid from such an animal kill mice rapidly.
3. Intraperitoneal injection of *Cl. botulinum* toxin is lethal for a dog, the blood from such an animal being toxic for mice.
4. The presence of *Cl. botulinum* toxin in the blood cannot be demonstrated by the mouse method after injection directly into the dog's normal jejunum through a Biebl loop.
5. *Cl. botulinum* toxin, injected directly into 24-hour closed high jejunal loops exteriorized according to the method of Biebl, could not be demonstrated in the blood or peritoneal fluid of dogs by the mouse method until evidence of seepage through the nonviable bowel wall or perforation of the intestinal segment was present.
6. *Cl. botulinum* toxin could not be demonstrated in the closed loop contents by the mouse method 12 to 24 hours after injection directly into 24-hour closed high jejunal loops of dogs, exteriorized according to the method of Biebl.

TABLE II

TOXICITY FOR MICE OF BLOOD, PERITONEAL FLUID, AND CLOSED JEJUNAL LOOP CONTENTS OF DOGS INJECTED WITH *Cl. botulinum* TOXIN DIRECTLY INTO THE EXTERIORIZED LOOP

NO.	TIME AFTER TOXIN ADMINISTRATION*	INTRALUMINAL PRESSURE	TOXICITY OF BLOOD	TOXICITY OF PERITONEAL FLUID†	TOXICITY OF LOOP CONTENTS
10	Control	37 cm. H ₂ O	0 0	0 0	+ +
	2 hr.		0 0	0 0	+ +
	11½ hr.		+ +	+ +	+ +
					(Loop contents injected unfiltered)
11	Control	30 cm. H ₂ O	0 0	0 0	0 0
	2 hr.	----	0 0	0 +	0 +
	12 hr.	34 cm. H ₂ O	0 0	+ +	0 0
	25 hr.	34 cm. H ₂ O	0 0	0 +	0 0
	47 hr.	91 cm. H ₂ O	0 0	0 +	0 0
					(Loop contents injected after Berkefeld filtration)
12	Control		0 0	0 0	0 0
	2 hr.		0 0	0 0	+ +
	12 hr.		0 0	0 0	0 +
	24 hr.		0 0	0 0	0 0
					(Loop contents injected after Berkefeld filtration)

*Samples aspirated before toxin administration are designated "control."

† +, death of mouse; 0, mouse alive.

filtered intestinal contents were mouse tested at 2, 12, 25, and 47 hours after administration of the toxin (No. 11, Table II). The contents of the isolated loop previously injected with toxin, as well as the dog's blood after toxin injection, were not toxic for mice even 71 hours after obstruction.

Apparently, the toxin is destroyed between 12 and 25 hours after its injection into the loop. Since no toxin could be demonstrated in the blood at any time, although the peritoneal fluid was questionably toxic, the experiment was repeated, culturing the liquids injected into the mice and culturing the heart blood and peritoneal fluid of the mice immediately after death.

EXPERIMENT 12.—A medium-sized dog was prepared with a Biebl loop of closed jejunum, 40 cm. in length, as described in Experiment 9. Twenty-four hours later samples of blood, peritoneal fluid, and Berkefeld-filtered loop contents were cultured in liver peptone and dextrose broth and injected into mice. Twenty cubic centimeters botulinum toxin (mouse potency, 2 to 6 hours) were then injected directly into the Biebl loop, and samples of blood, peritoneal fluid, and filtered loop contents aspirated at 2, 12, and 24 hours after toxin administration were cultured in the two media and injected into mice. As mice died they were immediately immersed in 5 per cent phenol for 10 minutes; the peritoneum and heart were opened under sterile precautions and the contained liquids were cultured (No.

POLYPOID DISEASE OF THE COLON

ANATOMICAL MEASUREMENTS OF THE COLON INCLUDING DESCRIPTION OF A COLONOSCOPE*

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POLYPOID disease of the colon is a pathologic condition that has long been recognized and frequently described. The terminology and classifications used in the literature regarding this disease are confusing. All clinical evidence supports the belief that there is a definite tendency for polypoid lesions of the colon to undergo malignant changes. The etiology of this disease is not understood. However, it appears that multiple polypoid disease limited to a segment of the colon differs etiologically and pathologically from multiple polypoid disease of the entire colon. The diagnosis is suggested by a carefully taken history which discloses changes in the patient's bowel habits, blood in the stool, and indefinite abdominal pain. The use of the sigmoidoscope and double-contrast stereoroentgenographs of the colon establish the presence of polypoid lesions in the colon. Various surgical procedures have been advocated for the early eradication of the tumor tissue. In a recent publication⁷ the above statements were discussed in detail.

Recently,⁷ I proposed that in selected cases when a segment of colon is involved with polypoid disease or when only a relatively few polyps are present throughout the colon it would seem rational that an attempt should be made to remove the tumors successfully without sacrificing the entire colon. It was proposed that polyps which could not be reached by the sigmoidoscope could be fulgurated through one or more properly placed colostomies.

ANATOMICAL STUDIES OF THE COLON AND THE DESCRIPTION OF A COLONOSCOPE

Realizing the danger of perforation of the bowel during fulguration of polyps, an attempt was made to ascertain the thickness of the colon in its various segments. In this study twenty-five adult colons were obtained from the pathology departments of Cook County Hospital and Presbyterian Hospital. From the beginning it was obvious that many sources of error were present. Whether the bowel is found to be distended or collapsed will alter the measurement of its thickness. Microscopic measurements will depend on the method used in cutting the

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was then separately transilluminated and a photoelectric cell was used to measure the amount of light which was transmitted. In this way two methods were utilized in determining the thickness of the colon. The results are tabulated in Table I. It will be seen that the large bowel increases in thickness as it reaches the distal portion, the right colon, thus, being the thinnest and the left colon the thickest. These findings are consistent with physiologic reports^{1, 4, 5} which state that the contents of the right colon are liquid and that in this region absorption takes place. The left colon serves as a reservoir⁶ for semisolid mate-

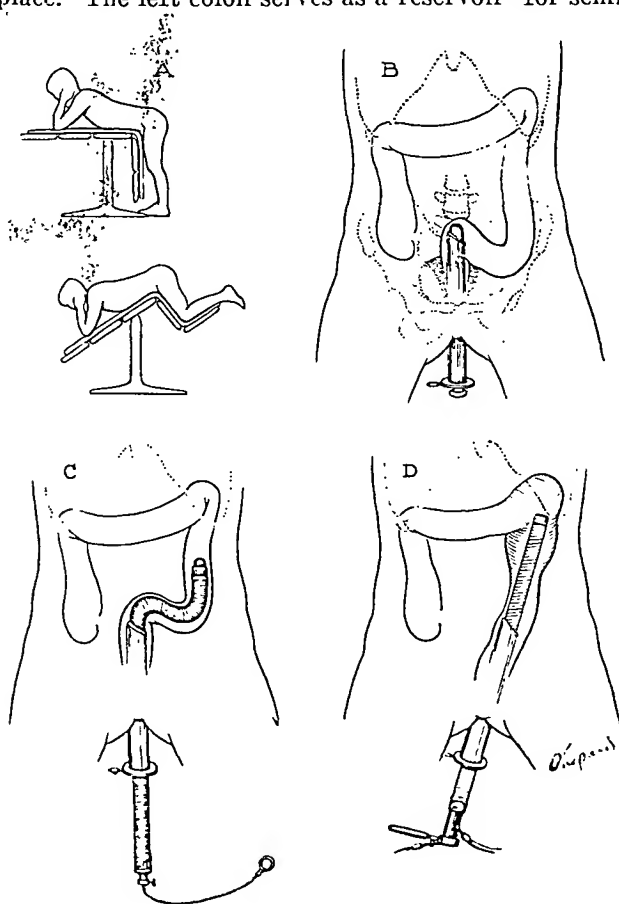


Fig. 2.—Diagrammatic drawings showing method by which colonoscope is introduced into left colon. A, Position of patient on table for introduction of scope; B, sigmoidoscope in place; C, flexible, rubber-covered scope passing around curves in the colon; D, flexible tube being straightened out by rigid scope.

rial. This accounts for its greater thickness. It would seem from this study that polyps could be fulgurated in any segment of the colon, but the greatest risk of perforation would be on the right side.

Fulguration of polyps through a scope, passed from below, is a common surgical procedure. This is usually done through 24 and 30 cm.

sections because it would be impossible to cut each section exactly alike. To obviate this, a block of colon measuring 3 by 2½ cm. was removed from each segment, stripped of its fat tags, and weighed. Each section

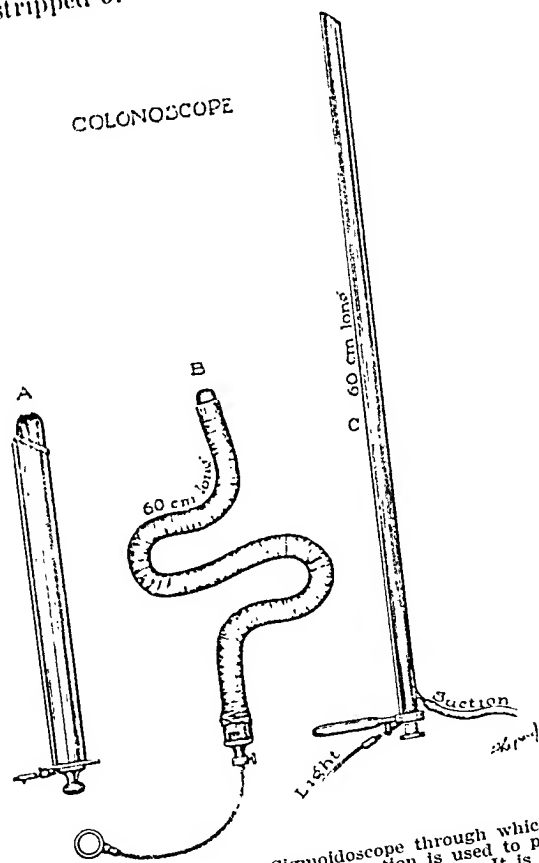


Fig. 1.—Colonoscope, 60 cm. long. A, Sigmoidoscope through which a flexible, rubber-covered scope (B) is inserted. This flexible portion is used to pass the curves in the lower colon and acts as a sheath for the rigid scope (C). It is proposed that the colonoscope will permit fulguration of polyps high in the left colon.

TABLE I
A STUDY OF THE THICKNESS OF TWENTY-FIVE COLONS REMOVED AT AUTOPSY

	AVERAGE WEIGHT IN GRAMS OF PORTION OF COLON MEASURING 3 BY 2½ CM.	TRANSMISSION OF LIGHT, IN FOOT CANDLES, AS MEASURED BY PHOTO-ELECTRIC CELL*
Rectum	2.139	39.17
Sigmoid	1.888	63.64
Descending	1.437	91.40
Splenic flexure	1.260	92.92
Transverse	1.291	93.68
Hepatic flexure	1.139	98.88
Ascending	1.214	90.28
Cecum	1.166	94.96

*Photoelectric cell readings were made by transmitting the illumination from 100 watt lamp through the tissue from a distance of 1 cm.

sufficient to reach the splenic flexure in the average colon. During the above-mentioned studies on the colon, the average distance from the splenic flexure to the anal outlet was found to be 60.4 cm., the longest being 92 cm. and the shortest 40 cm. Results of this study are tabulated in Table II.

TABLE II

LENGTH, MEASURED IN CM., OF VARIOUS SEGMENTS OF TWENTY-FIVE COLONS OBTAINED AT AUTOPSY

	AVERAGE	LONGEST	SHORTEST
Cecum and ascending	28.3	50	19
Hepatic flexure	10.0	12	6
Transverse	28.5	45	17
Splenic flexure	9.9	17	6
Descending, sigmoid, and rectum	60.4	92	40
Entire colon	137.1	192	95

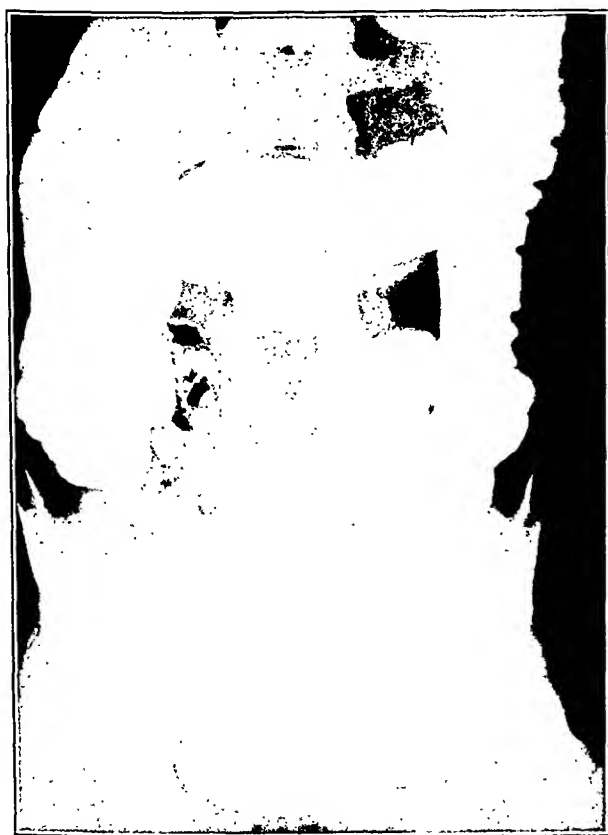


Fig. 4.—Barium enema showing normal colon pattern of patient in whom colonoscope was passed as shown in Fig. 3.

In order to introduce the instrument, the patient is placed face downwards on a tilt table² with the head lowered (Fig. 2 A). This enables the abdominal contents to fall forward.

scopes. Buie⁴ on several occasions has introduced a 45 cm. scope and by careful manipulation has been able to fulgurate polyps. However, when these heights are reached, much difficulty is encountered in maneuvering the scope around the curves in the colon.

Colonoscope (Fig. 1).—It occurred to me that by introducing a flexible metal tube through a sigmoidoscope (Fig. 2 *B*) it would be possible to pass the many curves in the lower bowel and reach the upper limits of the left colon (Fig. 2 *C*). When this level is reached, the flexible tube acting as a sheath could be straightened out by a rigid



Fig. 3.—X-ray showing colonoscope inserted well up in the left colon. Note the end of the scope is opposite the twelfth rib.

scope (Fig. 2 *D*). Through this scope, polyps could be fulgured. The principle on which the colonoscope is based is that a redundant colon, by necessity, has a long mesentery. Such a mesentery will permit the colon to be straightened out without stress, thereby being less painful to the patient.

The flexible portion of the scope is sufficiently pliable to pass any curve in the colon. It is covered with Penrose rubber tubing to prevent traumatizing the bowel. The length of the scope is 60 cm., which is

ABSENCE OF THE ANTERIOR MEDIASTINUM WITH REPORT OF CASE ASSOCIATED WITH CONGENITAL DIAPHRAGMATIC HERNIA

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ALTHOUGH compatible with life, an interpleural communication is one of the rarest anomalies of the chest. This is demonstrated by the fact that Kupfer¹ did not mention its occurrence in a study of mediastinal lesions in 6,000 autopsies. Moreover, in a thorough search of the literature only nine cases could be found. One of the earliest cases was recorded by Fräntzel,² in 1877, who observed at autopsy bilateral pneumothorax as a result of tuberculosis of the left lung and mediastinum with perforation of the latter structure. McCallum,³ in 1919, reported another case in a patient with tuberculosis of the right lung. The patient was receiving artificial pneumothorax therapy on the right side, and, after the eighth treatment, fluoroscopy revealed an area of transparency above the diaphragm on the left side. After the ninth treatment, a distinct pneumothorax was seen on both sides. A somewhat similar case was reported by Walsh,⁴ in 1924. In 1925, Dumarest and Bonafé⁵ reported a case in a man 35 years of age with tuberculosis of the left lung. Within a few moments after the performance of a pneumothorax on the left side, the patient complained of dyspnea and pain on the opposite side of the chest. An immediate roentgenogram revealed air in both pleural cavities, and relief of manifestations was obtained by aspiration of air from both pleural cavities. The case reported by LeWald,⁶ in 1926, had no evidence of tuberculosis. The patient experienced sudden pain in the right side while "vigorously" using an adding machine. Roentgenographic examination revealed a right pneumothorax, and one week later there was, in addition to an increase in the collapse of the right lung, a collapse of the left lung. Julien,⁷ in 1930, recorded another in a 24-year-old female with pulmonary tuberculosis. During the performance of a pneumothorax, it was observed that, in spite of the fact that air was being introduced into the right side, the left lung became collapsed but the right did not. For unexplained reasons the author concluded that an interpleural communication existed which permitted air to enter the left pleural cavity but not in a reverse direction. A somewhat similar case is cited by Ameuille⁸ in which lipiodol introduced in the right pleural cavity was seen to pass into the left through an opening anterior to the heart. Bilateral pneumothorax

That it is possible to introduce this colonoscope is attested by the accompanying x-ray picture (Fig. 3). It shows the scope extending well up in the left colon. Following this procedure, this patient was given a barium enema to show the normal colon pattern (Fig. 4).

It should be appreciated that the introduction of the instrument into the left colon is exceedingly dangerous and should be done only by a trained endoscopist. Also, there are many colons attached by short mesenteries in which it would be impossible to use this instrument.

It is my opinion that further work with this instrument will prove that its use will preclude, in many instances, the necessity for more radical surgery.

I wish to thank Dr. J. P. Nesselrod for his interest and cooperation in the development of this instrument.

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ease, but it should be differentiated from herniation and interpleural communication. Herniation of the mediastinum is the protrusion of part of the pleural sac contents with evagination of the mediastinal pleura into the contralateral hemithorax. This is common during the administration of a pneumothorax, but, according to Maier,¹² it may result from lesions within the chest even though pneumothorax does not exist. Pulmonary tuberculosis is the most common cause, due to atelectasis and fibrosis. Among other initiating factors are atelectasis from bronchial tumors, extensive unilateral suppurative bronchiectasis with pulmonary contractions and fibrosis, occluding intratracheal foreign bodies, and cystic disease of one lung. Usually the pressure differences have existed for a considerable period of time before herniation occurs.

Korol¹³ finds anterior mediastinal hernias as common on the right side as on the left, but he adds that posterior mediastinal bulging is rare on the right. This is explained by the fact that the esophagus relaxes in leftward displacement, but, on being pushed to the right, it resists by stretching, due to its diaphragmatic attachment on the left side. It is easier for the right lung to invaginate itself between the aorta and the esophagus because of the difference in the relations of the mediastinal pleura. The right pleura extends posterior to the esophagus, forming a recess behind it from the tracheal bifurcation to the diaphragm. The left pleura is not in direct contact with the esophagus. In lung prolapse there is no hernial sac, the parietal pleura being ruptured.

The case outlined herewith is one of a communication between the pleural cavities observed during left transthoracic diaphragmatic herniorrhaphy. In contradistinction to the above-mentioned cases, our case is characterized by total absence of any evidence of tuberculosis. In this patient the entire anterior mediastinum was absent, affording a clear view into the right hemithorax for the full length of the sternum. The heart and great vessels lay on the anterior surfaces of the vertebral bodies, and the right lung was compressed to such an extent that it was thought to be congenitally absent.

CASE REPORT

The patient, a white male, age 4 months, was admitted to the Hutchinson Memorial Clinic in July, 1937. The complaint registered by the parents was "grunting, wheezing, and difficult breathing." The present illness had existed for two months. There was occasional cyanosis. The child had a poor appetite and had failed to gain weight since the onset of his trouble. He had been very fretful during the previous two months and had suffered from a hacking cough for the two weeks prior to his admission. Physical examination revealed an undernourished child with prominent frontal bosses, an enlarged head, and bulging eyes. The thorax was large and rounded, convex anteriorly, and breathing was labored; the short, rapid respiratory efforts being produced with marked abdominal effort. The percussion note was dull over the lower half of the left lung posteriorly, tympanitic

following the production of unilateral artificial pneumothorax was observed in a case reported by Ioganson and Prozorov⁹ in 1932. For this reason a mediastinal communication was suspected but not proved. In 1933, Smith and Willis¹⁰ described another in a patient with pulmonary tuberculosis. By means of needles introduced in both pleural cavities it was possible to demonstrate increase in interpleural pressures on both sides during the injection of air on one side. The authors¹⁰ explained the fact that no channel of communication existed at autopsy because of the presence of adhesions between the mediastinal structures and the left lung and the complete obliteration of the left pleural space by adhesions.

In order for such interpleural defects to exist, the mediastinum, bounded by the spinal column behind, the sternum anteriorly, and the pleurae laterally, must be involved. Nitsch¹¹ has directed attention to two points at which the mediastinum is anatomically weak; viz., the area posterior to the upper part of the sternum in the region of the second to the fourth sternocostal junctions, and posteroinferiorly at the level of the eighth rib. An additional area of weakness between the vertebrae posteriorly and the esophagus anteriorly from the third to the fifth thoracic vertebrae has been described by Maier.¹² The vena azygos separates the upper from the lower posterior weak areas.

The anterior interpleural space contains little in the nature of resisting structure, being filled mostly by fatty and loose areolar tissue replacing the atrophied thymus gland. Korol¹³ states that the anterior mediastinal septum may bulge to reach the opposite axilla, allowing the upper lobe of the invading lung to occupy the entire anterior aspect of the opposite hemithorax. In some cases the upper anterior weak spot is represented by only a thin membrane, formed by a fusion of the right and left pleurae. The esophagus is the only organ running the length of the posterior mediastinum with no branches to other structures; therefore, it is subject to displacement. This occurs most readily in its lower part, where it turns forward from the aorta to reach the stomach. Lung hernias occur here between the esophagus and the aorta.

The pleural cavity on either side is protected against contralateral disturbances by the mediastinum. Respiratory movements, which cause a changing diameter of the thorax, make it necessary that this partition be somewhat flexible; however, it is unyielding to such an extent that one side of the thorax is protected from any change in pressure which might occur in the other, and a compensatory function is made possible. According to Richter,¹⁴ the mediastinum insures an equable circulation of blood and guards vessels and nerves from injuries likely to arise from unequal functions of respiration, deglutition, and heart action.

When pressure on either side is increased excessively, the mediastinum may be made to "give," which results from gradual loosening of its fibers. Such deviation of the mediastinum is common in thoracic dis-

mately the level of the seventh rib. The transverse colon passed medially from this point toward the mediastinum. The position of the cecum could not be determined, but at least one loop of intestine, which was probably either cecum or terminal small intestine, crossed the midline in the upper portion of the thorax to enter the right half of the thoracic cage. (Fig. 3.)



Fig. 2.—Anteroposterior roentgenogram of abdomen and chest made four hours following ingestion of barium meal. Loops of barium-filled small bowel may be readily seen in the left hemithorax.

On Sept. 19, 1938, the patient was admitted to the Tulane University Surgical Unit at Touro Infirmary for a diaphragmatic hernioplasty, which was done on Sept. 21, 1938. Under general anesthesia, subperiosteal resection of the seventh left rib was done and the pleura opened in the rib bed. Inspection revealed both small and large intestines herniating without a sac through a defect approximately 3 by 6 cm. in the left diaphragm. A Meckel's diverticulum was found on the herniated terminal ileum, but it was not removed. There was no anterior mediastinum present, the right hemithorax being clearly visible for the entire extent of the sternum. By positive pressure manipulations, the anesthetist could inflate the right lung to fill the pleural space on that side, and at this time it was believed that no left lung existed. On retrospect it is thought that the lung in-

over the lower two-thirds of the left lung anteriorly, and hyper-resonant over the entire right lung. The heart and mediastinum were displaced to the right. Breath sounds were diminished over the lower two-thirds of the left lung. The liver was palpable below the right costal margin. Roentgenographic examination of the thorax showed marked displacement of the heart and other mediastinal structures toward the right. There was increased density at the left base and in the hemithorax were scattered air pockets without fluid levels which were apparently gas-filled small and large bowel (Fig. 1). That there were loops of small bowel present in the left hemithorax was demonstrated by roentgenograms made following the ingestion of a barium meal (Fig. 2).

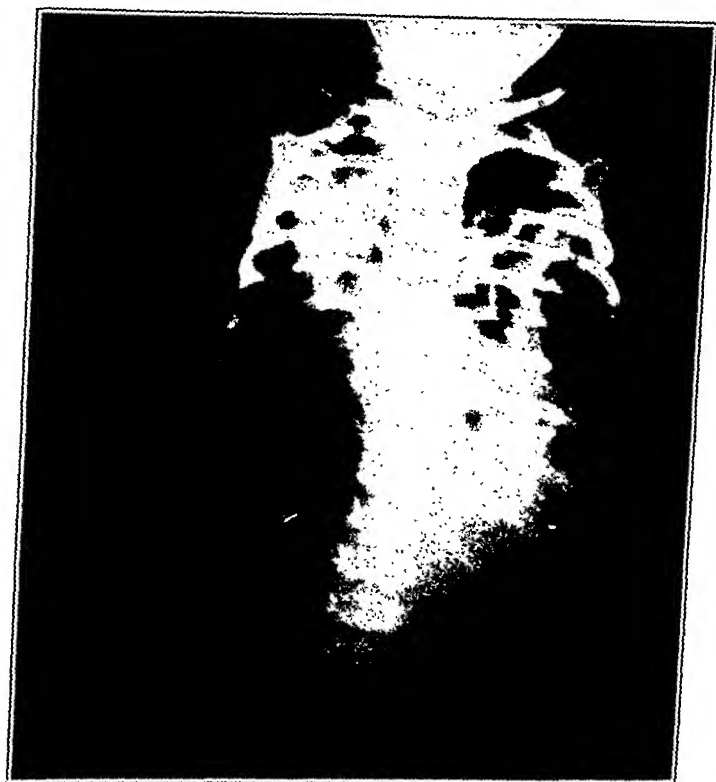


Fig. 1.—Anteroposterior roentgenogram of thorax before operation showing marked displacement of heart and other mediastinal structures toward the right. Increased density in left hemithorax with scattered air pockets without fluid levels suggests gas-filled small and large bowel.

A diagnosis of congenital left-sided diaphragmatic hernia was made. It was considered best not to operate immediately, but to wait until the child was older unless the symptoms became more pronounced, and this course was endorsed by the Department of Pediatrics.

On Sept. 17, 1938, the patient, now 18 months old, returned to the clinic. Breathing had improved and nutrition was satisfactory. Fluoroscopic and roentgenologic studies were done. Retrograde filling of the colon by means of a barium enema showed the sigmoid loop to be fairly straight. This and the descending colon ran upward along the left lateral abdominal wall to enter the thorax through an opening in the diaphragm (Fig. 3). What probably corresponds to the splenic flexure was observed along the lateral chest wall in its middle third at approxi-

showed a restoration of the left diaphragm. The instillation of iodized oil into the tracheobronchial tree revealed both lungs present (Fig. 4). There was very little displacement of the mediastinal shadow and approximately 50 per cent expansion of the left lung had occurred, there being some residual pneumothorax. Examination of the gastrointestinal tract by successive films taken at hourly intervals showed the stomach and duodenum to be approximately normal in position (Figs. 5 and 6). The small gut coils occupied a somewhat irregular position, but function appeared to be quite within normal limits, the stomach, duodenum, and most



Fig. 4.—Anteroposterior roentgenogram of thorax following instillation of iodized oil into tracheobronchial tree approximately twelve days after operation. Trachea, both main bronchi, and their secondary divisions are clearly visible. There is little or no displacement of the mediastinal structure, but there is some residual pneumothorax.

of the small intestine being empty at four hours with the meal occupying the cecum, which was in the right lower quadrant. At twenty-four hours the barium was seen to be in the descending colon, sigmoid, and rectum, which were approximately normal in position.

On Dec. 10, 1938, about two months after operation, examination of the patient revealed that the thoracotomy wound had healed completely and the lungs and heart were clinically normal. Roentgenologic examination at this time showed the heart and aorta about normal in size, shape, and position. The diaphragms were

flated was the left and that the right was not observed because it was compressed behind the left. In order to reduce the abdominal viscera, it was necessary to enlarge the incision downward approximately 4 cm., with resection of 2 cm. to the eighth and ninth costal cartilages. The intestines were then returned to the abdominal cavity, and the defect closed with interrupted sutures of No. 1 white silk. The primary suture line was then reinforced with interrupted mattress sutures of the same material. The thorax was closed in layers, interrupted sutures of No. 1 white silk being used throughout. The skin was approximated with



Fig. 3.—Anteroposterior roentgenogram of abdomen and chest made following barium enema. Parts of the transverse colon, splenic flexure, and descending colon may be visualized in the thorax.

interrupted vertical mattress sutures of the same material. A marine sponge dressing was applied, and the patient left the operating room in good condition. Two hours following the operation, a transfusion of 150 c.c. of unmodified blood was given.

The postoperative course was uneventful. On Oct. 3, 1938, the day of the patient's discharge, roentgenologic studies were made. Examination of the chest

pneumothorax in the contralateral side must be considered. Our case is unique in that it is the only one which we have been able to find in which the defect in the anterior mediastinum was so great that in reality a single pleural cavity existed. It also differs from the reported cases in that it was definitely congenital. Dr. Harold Cummins, Professor of



Fig. 6.—Lateral view of abdomen one hour following instillation of barium meal in stomach about twelve days postoperatively.

Anatomy at Tulane University, has kindly consented to present the following explanation for this unusual anomaly:

“Development of the Mediastinal Fault.—It will be recalled that the four definitively independent body cavities were in communication with each other during the early period of their embryonic development. In an embryo of about five weeks the coelom is still one continuous cavity,

smooth and rounded and in normal position. There was evidence of bone regeneration in the region of the left seventh rib. The lung fields were apparently normal. A large gas bubble was observed in the cardiac portion of the stomach (Fig. 7).



Fig. 5.—Anteroposterior roentgenogram of abdomen one hour following instillation of barium meal in stomach about twelve days after operation. The stomach, duodenum, and the remainder of the small bowel are approximately normal in position.

Whereas the previously described cases¹⁻⁹ of interpleural communication were probably due to small defects in the mediastinum with pathologic backgrounds, usually tuberculous, our case is one of a *complete absence of the anterior mediastinum which is undoubtedly of congenital origin*. Moreover, as pointed out by Oechsli and Miles,¹⁵ in some of these cases the communication was suspected only. In these cases, especially those with tuberculous lesions, the possibility of a spontaneous

to a position in dorsal relation to the heart, continued expansion of the pleural cavities extends to the parietal pleurae (and other mesoderm dragged with them) farther and farther around the pericardium, until finally in the fetus near term they nearly meet in front. After birth their relationship is brought even closer in the now more thinned anterior mediastinum.

"Keeping in mind that the anterior mediastinum represents the midline partition persisting after expansion of the parietal pleurae ceases, the history of the mediastinal defect in this case may be reconstructed. There are two possibilities to be considered. (1) The anterior mediastinum may have been initially normal, its absence being due to secondary atrophy under compression by the herniated intestine. (2) The anterior mediastinum may have been obliterated as a result of failure to arrest the progress of expansion of the pleurae toward the midline. Instability of other developmental processes in the present case is indicated by the diaphragmatic fault, and it is not impossible that the behavior of the enlarging pleurae may have been abnormal as well, independently of any direct compressing effects of the herniated intestine. Since, in the dog, the normal history of the pleural expansion is an interruption of the process at a point just short of dissolution of the anterior mediastinum, it is not improbable that stable development, whether in a dog or human fetus, might lead to complete disappearance of the mediastinal septum."

SUMMARY

1. A thorough search of the literature has revealed only nine cases of interpleural communication. The majority of these have been due to small defects in the mediastinum resulting from tuberculous involvement.
2. A case of complete absence of the anterior mediastinum associated with congenital diaphragmatic hernia is presented. This case is unique in that it is the only one we have been able to find in which the defect in the anterior mediastinum was so great that actually a single pleural cavity existed. Moreover, it differs from the reported cases in that it was definitely congenital.
3. The developmental explanation of this mediastinal fault is presented.

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though its form and relations indicate clearly which regions are to be isolated as the two pleural cavities and the peritoneal and pericardial cavities. The pleural cavities are represented by passages lying dorsal to the heart, one on either side of the primitive mesenteries of the esophagus and heart. These pleural passages, being very small in comparison, appear as constricted canals uniting the expanded pericardial and peritoneal regions of the celom. At about eight weeks the cephalic



Fig. 7.—Anteroposterior roentgenogram of thorax about two months after operation. Heart and aorta approximately normal in size, shape, and position. The diaphragms are smooth, rounded, and in normal position. The lung fields are normal and there is some evidence of bone regeneration in region of left seventh rib.

and caudal openings of the pleural passages have been completely partitioned from the pericardial and peritoneal cavities. In the meantime the lung buds, evaginating from the medial walls of the pleural passages, continue to enlarge. Accompanying growth of the lung buds, the now enclosed pleural cavities expand. From the original confinement

SPLENOSIS: MULTIPLE PERITONEAL SPLENIC IMPLANTS FOLLOWING ABDOMINAL INJURY

A REPORT OF A CASE AND REVIEW OF THE LITERATURE

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THE incidence of autotransplantation of splenic tissue following injuries to the upper abdomen is very rare. A case which recently came to our attention has stimulated a survey of this condition. To our knowledge no mention of such a clinical entity has been made in the American literature and we have been able to collect only seven cases in the foreign literature with definite history of trauma and two cases of questionable etiology.

In 1896, Albrecht¹ first noted the presence of multiple splenic nodules throughout the peritoneal cavity. He called these multiple accessory spleens. Schilling, in 1907,² found similar nodules on autopsy and also believed they were accessory spleens. In 1910, von Kuttner³ first brought to our attention the presence of multiple splenic nodules which he found in a patient four years following a gunshot wound of the abdomen that resulted in a rupture of the spleen. Foltin,⁴ in 1911, and von Stubenrauch,⁵ in 1912, reported a similar condition following severe trauma to the left upper abdomen. Von Stubenrauch in a subsequent paper quoted another case of multiple nodules of splenic tissue found in the peritoneum following an injury to the left upper abdomen. Lee, in 1923,⁷ Kupperman, in 1936,⁸ and Shaw and Shafi, in 1937,⁹ reported similar cases. Each of these cases, with the exception of the first two, gave a definite history of injury to the region of the spleen.

CASE HISTORY

Patient was a 28-year-old Puerto Rican housewife, para ii, gravida iv, who entered Knickerbocker Hospital on Nov. 21, 1938, for treatment of backache of three years' duration and leucorrhea of five months' duration. Family history is noncontributory.

Past History.—*Medical:* Reveals usual childhood diseases. *Surgical:* In 1919 at age of 9 years, she was in another hospital for ten months after having been struck by an automobile. At this time she had an exploratory laparotomy and was told that her spleen had been removed. *Menstrual:* Menstruation began at 12 years of age and was always regular, occurring every twenty-eight days and lasting four to five days. Dysmenorrhea was always present during the first two days.

In 1936 she first came to the Knickerbocker Hospital Gynecological Clinic complaining of backache. A third degree retroverted uterus was found and temporarily treated satisfactorily with a pessary. She returned in November, 1937, and com-

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regular. The masses were situated near the mesenteric attachment of the intestine as well as on its free border. The tissue surrounding each nodule showed no evidence of any gross anatomic change.

The viscera of the upper abdomen could be neither palpated nor visualized because of dense adhesions. The splenic site was entirely covered with thick bands which prevented the determination of the presence of any splenic tissue. We felt at this time that we were dealing with a case of diffuse endometriomas and decided to remove both ovaries. Nodules were removed from ileum, sigmoid, and omentum for pathologic study. The abdomen was closed in layers with interrupted absorbable sutures.

The postoperative course was complicated by moderate abdominal distention and occasional vomiting. Temperature remained normal. Wound healed by primary intention and patient was discharged on the eleventh postoperative day.

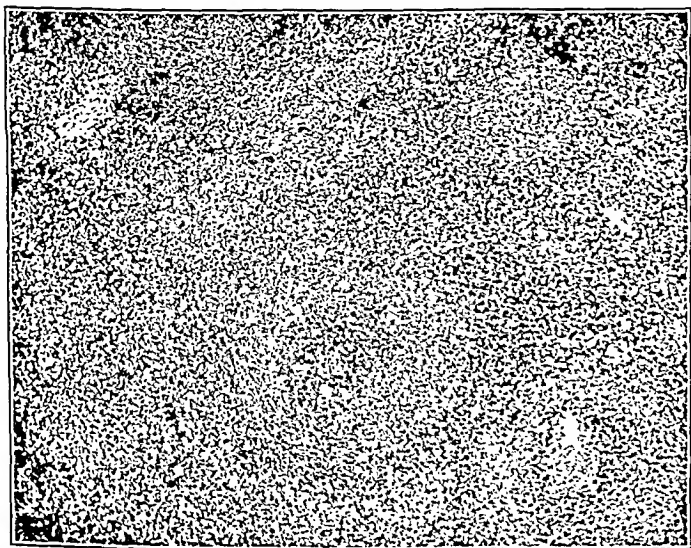


Fig. 2.—Trabeculae and follicle formation. Clear spaces indicate sinuses. ($\times 70$.)

Pathology Report.—Upon microscopic examination of the nodules, they presented a collagenous capsule containing a few scattered smooth muscle fibers and a small number of elastic fibers (Fig. 1). Emanating from the capsule were some delicate strands of connective tissue containing elastic fibrils which traversed in broken fashion the peripheral portion of the nodule. The arteries branched for a short distance with these trabeculae, but were subsequently seen deep in the structure of the nodule entirely free of any supporting trabecular-like substance. The background of the nodule consisted of a rich reticular network, the fibers of which communicated with the adjacent trabeculae. The reticulum formed well-defined sinuses within the lumina of which were lymphocytes, occasional mononuclear cells, and polymorphonuclear leucocytes. The intersinusoidal areas contained lymphocytes and large monocytes, consisting of pale vesicular nuclei enclosed in a fairly rich, pale eosinophilic cytoplasm. Several well-defined follicles were seen (Fig. 2), one or two of which contained minute hyaline foci. The histologic characteristics were those of splenic nodules.

DISCUSSION

The problem which immediately presents itself for discussion is whether these nodules were implants or accessory spleens. The usual

plained of recurrent lower back pain and weakness. The uterus was retroverted and tender on motion. A diagnosis of chronic parametritis was made and the patient was given a series of intradermal sterile milk injections with no improvement of her back pain. In April, 1938, postexertional pain developed in both lower quadrants. At this time she also had a leucorrhea. An erosion of cervix was found. Her pain and leucorrhea continued until admission.

Examination on admission revealed a well-developed, well-nourished Puerto Rican female who did not appear acutely or chronically ill. Temperature, 99°; pulse, 98; respiration, 20. Except for abdominal and vaginal findings, her physical examination was negative. There was a firm 3½ inch left upper paramedian scar about 1¾ inches wide. There was very slight tenderness to deep palpation in both lower quadrants. No abdominal masses could be felt. Vaginal examination revealed a firm and smooth cervix which was in the axis of the vagina and had a transverse laceration. There were fullness and tenderness in right fornix and the adnexae were somewhat thickened. The body of the uterus was not enlarged; it was anterior in position and pulled to the right. *Laboratory Data:* Urinary findings were normal. Blood count revealed a moderate anemia. Cervical smear showed a few white blood cells but no intracellular organisms. On her sixth hospital day, a laparotomy was performed for chronic adnexitis and cystoma of right ovary.

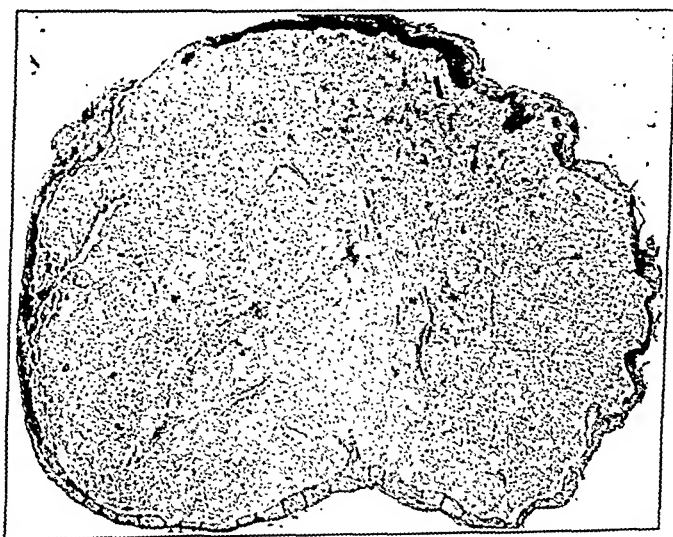


Fig. 1.—General topography of nodules (×15).

Operation.—The peritoneal cavity was opened and the pelvis explored through a 3-inch Pfannenstiel incision. The uterus was pear-shaped, smooth in surface and contour, was situated anterior, firm, and not enlarged. The Fallopian tubes were moderately injected but not indurated. The walls were thin and the lumina patent. The ovaries contained numerous follicular cysts, the right was larger than the left and contained a hemorrhagic cyst and several corpora lutea. On the parietal peritoneum, greater omentum, ileum, ascending colon, and sigmoid were numerous purple-red, sessile nodules measuring 1 mm. to 2 cm. in diameter. These nodules were covered with peritoneum and were intimately connected to the structures to which they were attached. These tumors were soft to touch and grossly resembled hemorrhagic cysts. The surface of each nodule was smooth and its contour was

CASE HISTORY (FOLTIN)

A 9-year-old boy received a severe abdominal trauma in a street accident. A short time after the accident a ruptured spleen was removed. During the next six years, the patient had recurrent attacks of pain in right lower quadrants. Laparotomy was performed about six years after the first operation for a chronic appendicitis. Multiple nodules were found throughout the abdominal cavity. One was removed from the sigmoid. On microscopic examination, it showed typical structure of spleen, including lymph follicles.

CASE HISTORY (VON STUBENRAUCH)

A splenectomy was performed on a male who thirty-six hours previously had been crushed between a pole and a cart. The spleen had been torn in two with a 10 to 12 cm. separation. Ten months later the patient was operated upon for ileus. At this time a number of tumors ranging from the size of hemp seed to pea size and with color of spleen were found on the greater omentum, transverse mesocolon, and small intestine. Histologic examination showed a thick fibrous capsule sending trabeculae, unlike splenic trabeculae, into the interior. The pulp was typical of spleen. However, no typical lymph follicles were present but only indefinite collections of lymphocytes. In Oltman's case multiple nodules of splenic tissue were found on the peritoneum subsequent to traumatic rupture of the spleen. Von Stubenrauch concluded that the nodules were formed from "seeds" of splenic pulp scattered throughout the peritoneum at the time of rupture.

CASE HISTORY (LEE)

A 29-year-old male with a history of splenectomy after a crushing injury to the abdomen at the age of 14 years had enjoyed good health until one day before admission when he developed symptoms of ileus. On laparotomy the small intestine was found distended and studded with small, sessile, greenish black tumors. Obstruction was due to an adhesive band from the site of old scar to small intestine. The whole peritoneum covering small intestine and mesentery was covered by sessile and pedunculated tumors varying in size from that of a pinhead to $1\frac{1}{2}$ inches, about 200 to 300 in number. Microscopically, they showed splenic tissue with trabeculae and follicles.

Lee made no comment as to whether these nodules were implants or not.

CASE HISTORY (KUPPERMAN)

A 15-year-old boy was run over by a tram and sustained a ruptured spleen. A splenectomy was done. Six months later a laparotomy was performed in the course of repairing a hernia and diastasis of the wound. About 100 nodules were seen on the small and large intestines. These grossly and microscopically resembled spleen.

Kupperman labeled these nodules "accessory spleens."

CASE HISTORY (SHAW AND SHAFI)

A 20-year-old Egyptian male was admitted in coma and died of uremia. History disclosed that the patient had had a trauma to his left side followed by splenectomy. On autopsy the spleen was found absent. There were no accessory spleens present. Eighty-two transplants, varying in size from 0.2 to 2 cm., were present, eighty on peritoneum, one in left pleural cavity, and one imbedded in

location of accessory spleens is in the gastroligament. However, they have also been found about the pancreas, rarely in the omentum.¹¹ Their usual number is two to six, but as many as forty have been described.¹² Following splenectomy the accessory splenic tissue has been known to undergo moderate hypertrophy. Although accessory spleens are one of the most commonly found congenital anomalies at autopsy, they are always confined to the locations mentioned above. It is noteworthy that only in those cases in which there was a history of severe upper abdominal trauma were splenic nodules located in such atypical locations as the pleural cavity, the dome of the diaphragm, and on the peritoneal surfaces of the small and large intestines and even of the liver. In view of the history of trauma and the bizarre location of the splenic nodules in our case, we believe it was one of splenic implantation rather than of multiple accessory spleens.

Whether the cases of Albrecht¹ and Schilling² were accessory spleens or multiple implants, it is difficult to say. In Albrecht's case¹ there was no history of trauma elicited, but on post mortem many nodules were found in the greater omentum, in Douglas' pouch, and on both domes of the diaphragm. There was severe scar tissue about the left kidney and about the spleen. It is possible for traumatic rupture of the spleen to take place and a patient to recover without operative interference. Schilling's case² was that of a 47-year-old female who died of carcinoma of the cervix with invasion of the bladder and a right pyelonephritis. There was no history of trauma in this case either, but there were several nodules found on the peritoneum. On the greater omentum were forty-two nodules ranging from the size of a pea to that of a cherry with microscopic structure of spleen. Lymph follicles were seen in many of the nodules.

It appeared to us that in the following cases there is no doubt that at the time of rupture of the spleen there was a "seeding" of the peritoneum by splenic pulp, rather than a hypertrophy of pre-existing accessory spleens.

CASE HISTORY (VON KUTTNER)

A man was shot in the abdomen during a hunting trip. Under the most primitive conditions, a laparotomy was performed four hours later and the spleen removed. A small piece was left in situ. Four years later he died of coronary sclerosis. An autopsy was done by von Becke. Eighty to one hundred nodules were found scattered throughout the peritoneal cavity. Two nodules, the size of a peach and of a cherry, were found at the site of the spleen. The smaller nodules had microscopic structure of splenic pulp but had no trabeculae or lymph follicles. However, the nodules at the splenic site were typically spleen.

Kuttner³ believed that the case he reported was one of accessory spleens and not implants. Foltin⁴ was the first to suggest that they were splenic implants.

CASE HISTORY (FOLTIN)

A 9-year-old boy received a severe abdominal trauma in a street accident. A short time after the accident a ruptured spleen was removed. During the next six years, the patient had recurrent attacks of pain in right lower quadrants. Laparotomy was performed about six years after the first operation for a chronic appendicitis. Multiple nodules were found throughout the abdominal cavity. One was removed from the sigmoid. On microscopic examination, it showed typical structure of spleen, including lymph follicles.

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the left margin of the liver. All were covered by serosa. Some were sessile and others pedunculated. One-half were distributed on diaphragm, greater omentum, and pouch of Douglas. Six were on peritoneal surface of the old surgical incision.

The implants at the site of the surgical incision, the authors suggested, may have been implanted there when the spleen was removed through the wound. A rent in the diaphragm accounted for the pleural transplant since there were old dense adhesions between the base of the left lung and the posterior end of the left dome of the diaphragm.

Microscopic examination of nodules showed that blood vessels did not enter through a hilus but branched into smaller vessels which penetrated the capsule around its circumference. The capsule was unlike normal spleen; there was no smooth muscle and elastic tissue was poorly formed and merged with surrounding tissue. Septa were similar to the capsule. The pulp was exactly that of spleen but in only two of the transplants was there an attempt at lymph follicle formation. An additional in-

TABLE I
SUMMARY OF CASES IN THE LITERATURE

AUTHOR	DATE	REASON FOR RELAPAROTOMY	TIME AFTER SPLENECTOMY	LOCATION OF NODULES	NUMBER
Albrecht	1896	Autopsy	No history of trauma or splenectomy	Greater omentum, Douglas' pouch, and both domes of diaphragm	Numerous
Schilling	1907	Autopsy	No history of trauma or splenectomy	Greater omentum, peritoneum of anterior abdominal wall and of pelvis	42 on greater omentum, several more on peritoneum
Von Kuttner	1910	Autopsy	4 yr.	Scattered throughout the peritoneum	80 to 100
Foltin	1911	Chronic appendicitis	6 yr.	On loops of large and small intestines	Numerous
Von Stubenrauch	1912	Ileus	10 mo.	Greater omentum, transverse mesocolon, and small intestine	Numerous
Oltman (quoted by von Stubenrauch)	1919	Not stated	Not stated	Throughout peritoneal cavity	Numerous
Lee	1923	Ileus	15 yr.	Small intestine and mesentery	200 to 300
Kupperman	1936	Postoperative hernia	6 mo.	Small and large intestines	100
Shaw and Shafi	1937	Autopsy	Not stated	Abdominal wall, pleural cavity, liver, diaphragm, Douglas' pouch, and greater omentum	82

teresting microscopic finding was the presence of several miliary tubercles which were found in transplants (patient had fibrous caseous apical tuberculosis).

In this case the pulp was apparently the only tissue of splenic origin in the nodules; the capsule and septa were believed to have been derived from surrounding tissue; the vascular supply entered through periphery rather than through a hilus.

Shaw and Shafi⁹ expressed the opinion that these splenic nodules were truly implants and not accessory spleens. They based their opinion on the peculiar location of the nodules, their great number, and their atypical microscopic appearance.

It has been shown experimentally that splenic tissue may be implanted in the peritoneum and readily survives transplantation. Von Stubenrauch⁶ removed the spleen in several dogs, crushed the pulp, and "seeded" these throughout the peritoneal cavity. On sacrificing the dogs from one to three months later, he was able to demonstrate the same picture he had described in man. Marine and Manley, in 1920,¹⁰ and Perla, in 1936,¹¹ showed the readiness with which autoplasmic splenic transplants grow in rabbits and albino rats although these transplants were into the abdominal wall and not the peritoneum.

SUMMARY AND CONCLUSIONS

1. A case is reported of autotransplantation of splenic tissue throughout the abdominal cavity following trauma of the spleen.
2. The surgeon should bear the above condition in mind in a patient having a history of severe abdominal trauma, since these nodules may grossly resemble endometriomas.
3. These implants histologically resemble normal splenic tissue except for paucity of lymph follicles, trabeculae, and occasionally in atypical arrangement of blood vessels.
4. The great number, the widespread location unusual for accessory spleens, and the history of severe trauma to the spleen lead us to believe that these nodules are not accessory spleens but rather definite splenic implants.
5. There were no abnormal manifestations from the splenic nodules in spite of their widespread distribution and intimate contact with the abdominal viscera in any of the reported cases.
6. We offer the term splenosis to describe this condition.

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A NEW TECHNIQUE FOR CUTTING SKIN GRAFTS

INCLUDING DESCRIPTION OF NEW INSTRUMENTS²

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THE cutting of satisfactory skin grafts of proper size and thickness is an art mastered by few. If, by any practical means, it could be reduced to a simple technical procedure, the grafting of fresh and healthy granulating areas would be practiced more universally, thus avoiding the formation of many unsightly and disabling scars and effecting a great economic saving to the individual patient and to the community. Also, it would be a great advantage to be able to obtain more usable graft from a given donor area, as well as single grafts of a sufficient size to cover large defects completely when good cosmetic results are imperative.

Satisfactory grafts can be cut if the following conditions are fulfilled: (1) a suitable donor surface, (2) satisfactory instruments, and (3) an operator of sufficient skill in the art of cutting skin grafts. A number of devices¹⁻⁴ have been described to facilitate the cutting of skin grafts, but unfortunately none of these schemes are entirely practical. Blair and his coworkers have described a very good suction retractor and knife, but their use requires more than ordinary skill.

It is relatively simple, mechanically, to devise a knife equipped with a guide to cut to an even depth into a uniform donor area. To obtain a sufficiently uniform surface, it is merely necessary to stretch the donor skin moderately taut and elevate it slightly above its surroundings. The required instruments and a practical technique will be presented.

DESCRIPTION OF THE APPARATUS AND TECHNIQUE

A detailed description of an instrument would be inappropriate. However, for an intelligent understanding of its technical use, the fundamental principles of its make-up must be outlined. The complete armamentarium consists of a pair of needle retractors for the skin, a traction bar to maintain uniform skin tension, a holder for the razor blades which serve as the cutting edge, and a frame to carry the cutting edge and regulate the depth of the cut (Fig. 1).

The needle retractors, Fig. 1A, are pressed into the skin and attached to the traction bars, Fig. 1B, under the desired tension. This gives a flat, uniform surface appropriate for the cutting of a graft (Figs. 5-8).

¹Preliminary report before San Francisco County Medical Society, December 21, 1937.

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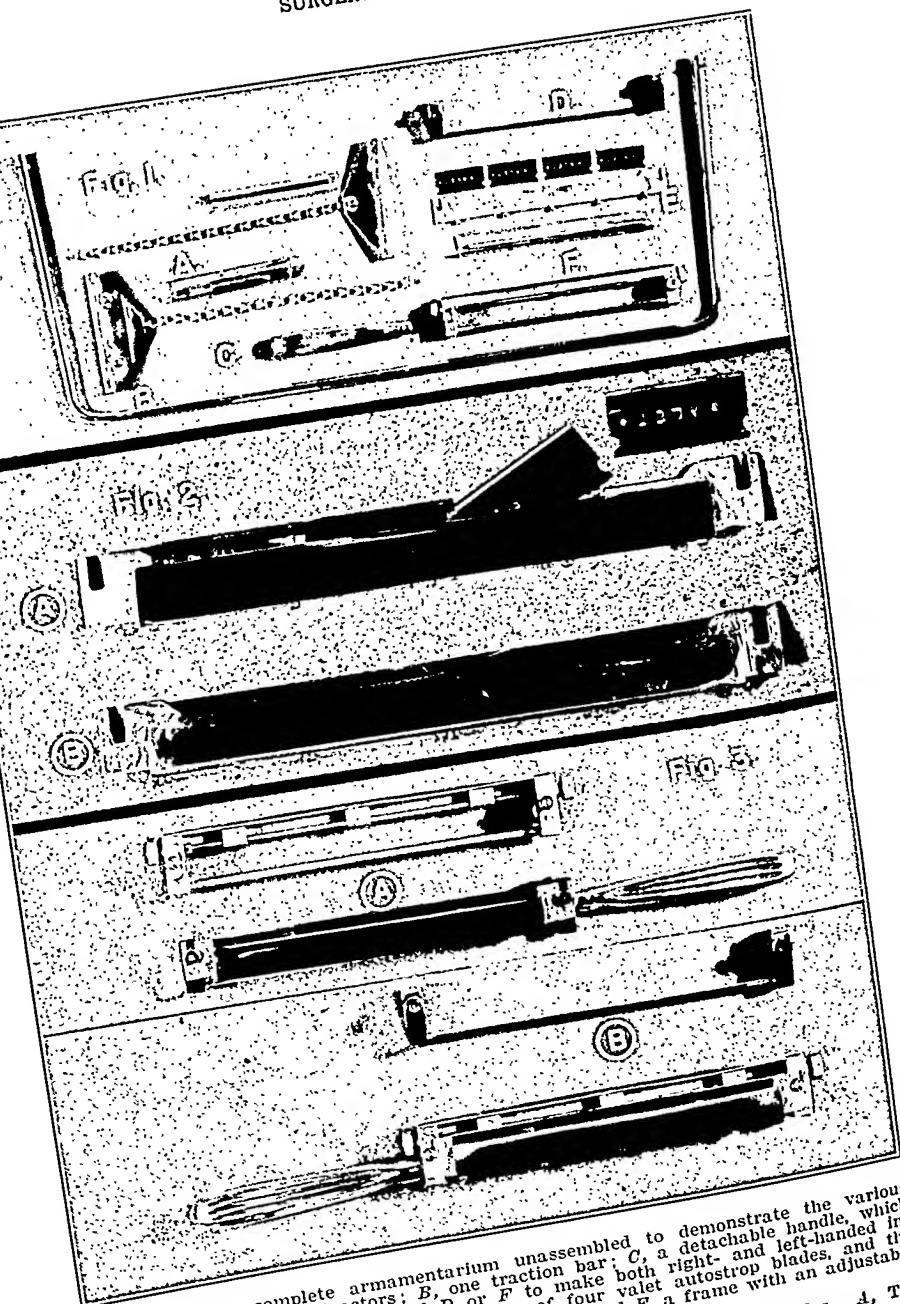


Fig. 1.—The complete armamentarium unassembled to demonstrate the various parts: A, two needle retractors; B, one traction bar; C, a detachable handle, which can be secured into either end of D or F to make both right- and left-handed instruments; D, a simple frame; E, a group of four valet autostop blades, and the holder for the blades which has been taken apart; and F, a frame with an adjustable depth guide.

Fig. 2.—Illustrating the blade holder and manner of changing blades. A, The blades are slipped into the holder and held rigidly in place by two flat springs. B, The assembled holder and blades.

Fig. 3.—A, The handle and cutting edge are attached to the simple frame to give a knife for free-hand cutting. B, Here the handle and cutting assembly are attached to the frame fitted with an adjustable depth guide. Note: The handle can be attached to either end of the frames for use both as right- and left-handed instruments.

A folded towel is placed under each retractor to elevate the stretched strip of skin slightly above the level of the surface of its surroundings.

The cutting edge consists of four valet autostrop safety razor blades secured end-to-end in a simple holder (Fig. 2). This cutting edge is extremely sharp, since new blades can be used at each operation. These blades are available at any corner drugstore and eliminate the bother and expense of sharpening special knives which present a real problem in other than metropolitan areas. This cutting edge is attached to the frames illustrated in Fig. 3A and B. The schematic drawing (Fig. 4) illustrates the principles of the assembly.

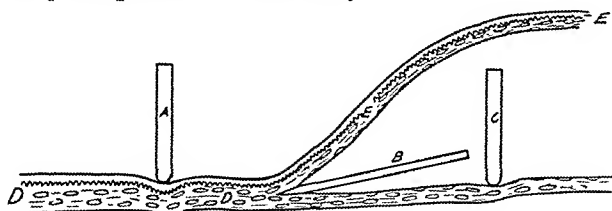


Fig. 4.—Illustrating the principles of the apparatus. The full thickness of the skin, *D*, is stretched taut in practically a plane surface. The depth guide, *A*, rides on the skin surface in front of the blade, *B*. The guide, *C*, rides on the cut surface behind the blade. The blade, *B*, is suspended between *A* and *C*. *A* can be adjusted up and down to cut the desired thickness of graft, *E*. *B* is an extremely sharp razor blade and cuts without pressure. This results in grafts of unusually uniform thickness.

The thickness of the grafts is regulated by adjusting the depth guide *A*, Fig 4. A piece of skin under tension naturally tends to lengthen, and so the graft obtained will be wider and shorter than the path actually cut. The relaxed graft behind the knife is about 20 per cent wider than the path cut on the stretched surface (Fig. 8).

DISCUSSION

This technique is extremely simple and can be acquired by any surgeon of ordinary dexterity. Suitable grafts will be obtained at the first attempt and, with a little practice, large grafts of uniform, desired thickness can be cut routinely. Since the skin being cut is under tension and raised above the surrounding area, the cut edges will be abrupt and more serviceable graft can be obtained from a given donor area. Also, since the skin is placed under tension, it is just as simple to cut grafts from a loose, atrophic skin on any part of the body as from a firm, smooth thigh.

A graft is readily cut to pattern. Obviously, the pattern must be outlined on the donor area before it is placed under tension. The borders are controlled by applying pressure ahead of the blade at the desired points. In this manner tattoo marks are easily excised, provided the pigment does not involve the full thickness of the skin. The healing of the donor area and the use of the grafts are the same as in any other procedure. Large grafts of uniform thickness are routinely obtainable.

Fig. 6.

Fig. 8.

Fig. 5.

Fig. 7.

Figs. 5-8.—See opposite page for legends.

CONCLUSION

A simple technique and practical armamentarium have been described which, with little practice, will permit the surgeon of ordinary skill to cut excellent grafts of any desired thickness.

The method is rapid. The instruments are sturdy and easily adjusted. A novel cutting edge has been provided which eliminates special knives. The use of a standard safety razor blade has eliminated dependance on an expert knife grinder and has made an unlimited supply of sharp cutting edges available in out-of-the-way places. This should prove to be of considerable advantage and encourage the use of the proper type of skin graft for covering defects at the optimum time.

This method of cutting grafts in no way alters the healing of the donor area or the technique of applying expertly obtained grafts, and so no discussion of this phase of skin grafting is given.

The use of the retractors and traction bar to fix and elevate the donor area facilitates the cutting of grafts with an ordinary knife.

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Fig. 5.—Illustrating the application of the needle retractors and the traction bar to give a donor surface under uniform tension and raised slightly above the surrounding skin.

Fig. 6.—Illustrating the technique of cutting. The left hand and fingers make lateral pressure on the edges of the path to be cut. This maneuver elevates the donor surface and enables one to cut the edges abruptly. At this stage the depth guide is adjusted to give the desired thickness of graft.

Fig. 7.—Illustrating the completion of the cut.

Fig. 8.—Illustrating the graft and the donor bed. The relaxed graft is shorter and wider than the taut donor bed. The degree to which this occurs depends on the character of the donor skin. The edges are sharp and abrupt. Note: Little bleeding occurs at the donor site while tension is maintained. If the tension is continued for a short time, little bleeding will occur subsequent to its release.

A NEW APPENDICAL CLAMP

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THE instrument herein described combines the function of the traditional split sponge used to protect the cecum during the amputation of the appendix and the clamp usually employed to empty the lumen of and anchor the appendix to the split sponge. It is composed of an upper and a lower arm. To the upper arm is attached, by means of a spring, a blade which milks the appendical lumen empty of its contents as it slides over the appendix while closing the clamp. The lower arm is supplied with a flat blade with a slit in it, which takes the place of the split sponge.

Once the mesoappendix is tied and the appendix is freed and ligated, the clamp is introduced by inserting the appendix at the constriction produced by the ligature into the slit in the flat plate on the lower

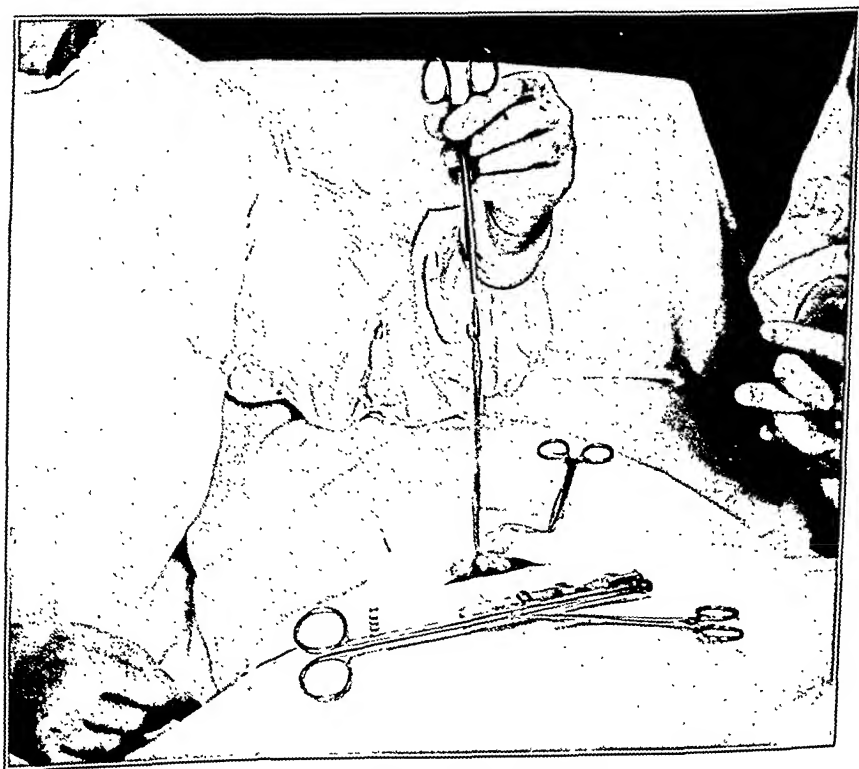


Fig. 1.—Closed clamp by freed appendix.

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arm of the clamp. The organ is then laid flat on the broad plate attached to the lower handle of the clamp. The upper arm of the clamp is brought down while the blade attached to it slides over the base of the appendix from the ligature up, milking thereby the appendix and emptying its lumen at the site of proposed section. The clamp is locked, thus anchoring the appendix firmly to the clamp preparatory to section. The appendix is then severed half-way by the carbolic knife or cautery beyond and between the border of the sliding

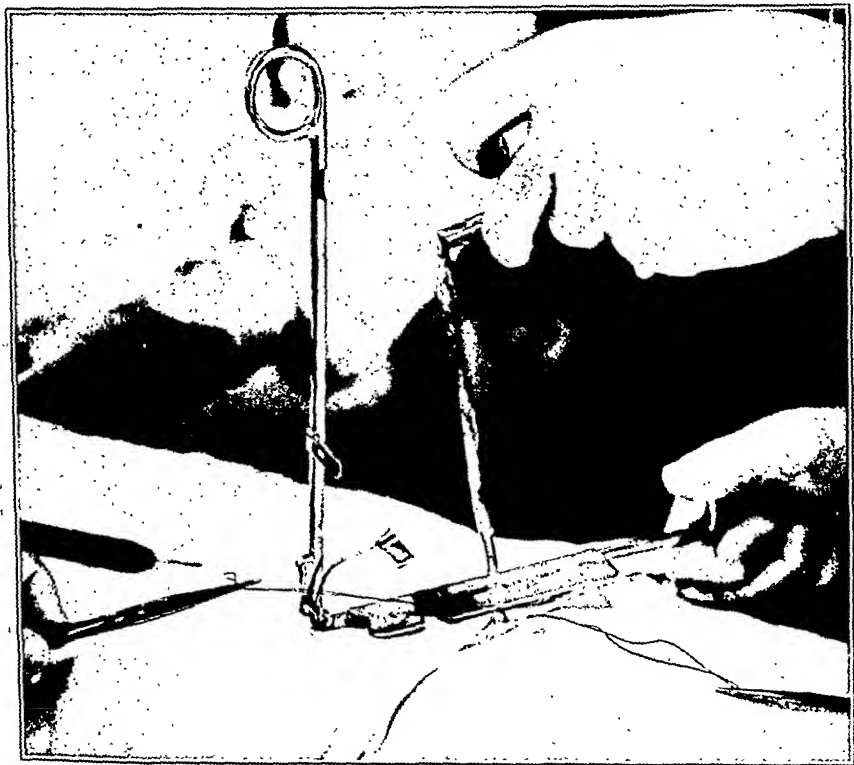


Fig. 2.—Clamp opened preliminary to insertion of appendix.

blade and the ligature. The lumen of the stump is cauterized and the section of the organ is then completed. The clamp is withdrawn and discarded with the appendix still attached. The ligature on the stump is cut and the cecum reposed with or without inversion of the stump.

The use of this clamp facilitates emptying the lumen of the appendix at the site of section; protects the cecum from injury with the knife, contamination with carbolic, or burn with the cautery; and simplifies the discardure of the amputated organ. This clamp has the added advantage over the gauze sponge of not being inflammable when employing the thermocautery.

Fig. 3.

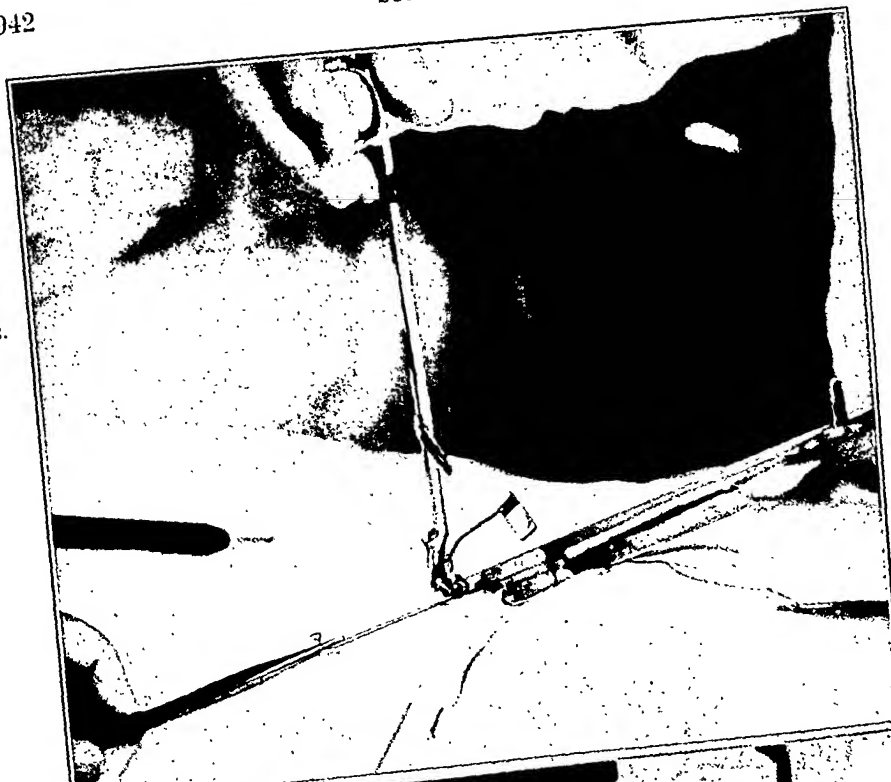
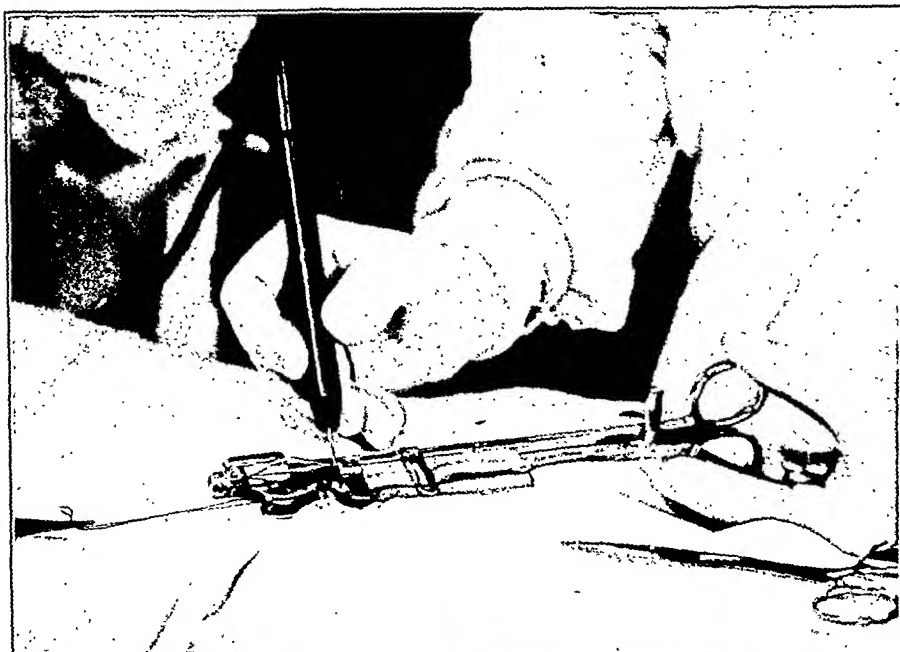


Fig. 4.



Fig. 3.—Appendix in place.
Fig. 4.—Clamp being closed; sliding blade milks appendix empty.

5.



6.

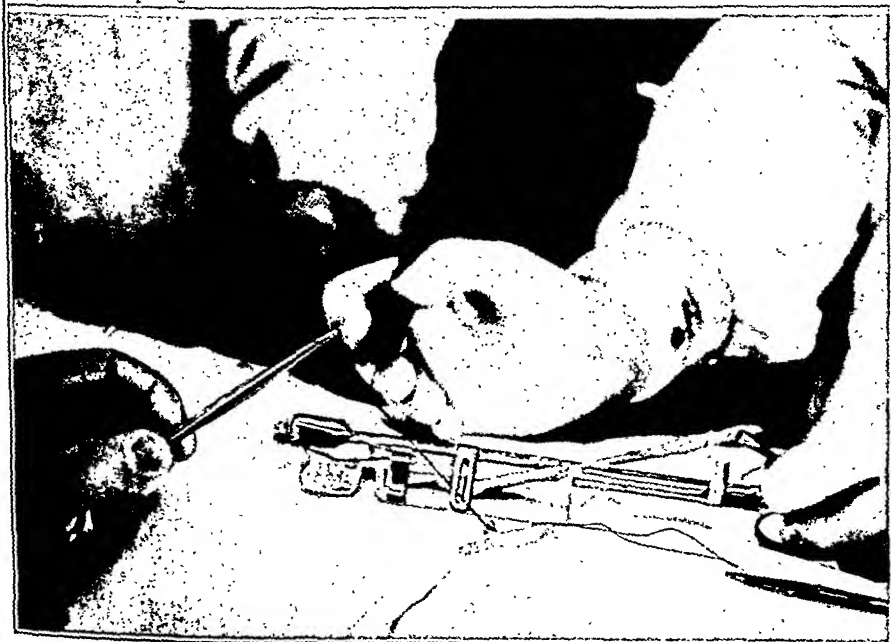


Fig. 5.—Clamp locked and cautery in use.

Fig. 6.—Clamp with appendix attached is withdrawn.

PERIRENAL LIPOMA

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THE case here reported is unusual, both because of the rarity of perirenal lipoma and because of the satisfactory recovery of this patient after removal of the tumor. It is of interest to the surgeon and the pathologist, as few have encountered this tumor at operation or autopsy.

A review of the literature in 1929 by Elansky¹ revealed 150 cases; since his report there have been described fifty-four additional cases.²⁻⁴ Students of the subject have found the immediate postoperative mortality to be about 20 per cent. The immediate cause of these deaths is shock from hemorrhage (spleen, liver, vena cava), injuries, or long operative procedures. Among later complications causing death are frequently listed peritonitis, necrosis of the intestine, phlebitis, pneumonia, and pulmonary embolism. Lacene,⁵ in discussing the prognosis, cites an eventual mortality of 54 per cent in the cases that were followed. The high mortality is largely due to late recurrences, many of which proved to be inoperable sarcomas.

CASE REPORT

The patient, a white female, 62 years of age, was admitted to St. Margaret's Hospital, March 13, 1939, complaining of a mass in the left side of her abdomen. She stated that she had been aware of the presence of the mass for the preceding two years, but it had not caused her any marked discomfort other than occasional mild colicky pains in the region of the mass. There was no history of nocturia, hematuria, urgency or frequency of urination. Fearing that she had a cancer, she visited her physician who advised hospitalization.

Physical examination revealed a 62-year-old white female, fairly well nourished and well developed, lying in bed, not acutely ill, in no apparent pain or distress. Blood pressure, 170/64; pulse, 80; respiration, 20; temperature, 98.5° F. The head was essentially negative, and the chest symmetrical. The breasts were large and flabby. The lungs were clear. The abdomen was moderately rounded and palpation revealed no rigidity, increased resistance, or tenderness. In the left upper quadrant was felt a mass about two inches wide and approximately four inches long that could be rolled beneath the examining hand. It was soft and spongy and its edges were sharply defined.

Urinalysis revealed a specific gravity of 1.010, acid in reaction, with a slight trace of albumin, but no sugar or acetone, few white blood cells, many urate crystals. Blood count showed 3,800,000 red blood cells; hemoglobin, 70 per cent; white blood cells, 7,000. The differential count showed 70 per cent polymorphonuclear leucocytes, 24 per cent lymphocytes, 6 per cent monocytes.

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A pyelogram with diodrast revealed, in the preliminary plate, no stone in the genitourinary tract. Diodrast: seven minutes, right kidney was normal in appearance, diodrast was excreted; nonfunction of the left kidney; fifteen minutes, normal function of right kidney, no function of left. There is a large tumor of left abdomen. Preoperative diagnosis is tumor of left kidney.

Operation was performed March 15, 1939, and tumor of left kidney excised. Left lumbar incision extending from the costovertebral angle downward, swinging forward and terminating 1 inch above and 2 inches in front of anterior superior spine, revealed a large mass extending well up beneath the diaphragm and down in the muscle and fascia divided and retracted, exposing the perirenal region. Exploration revealed a large mass extending through the abdominal wound and in front of this the region of the kidney pedicle. Kidney was lying above and that portion which mass. Mass was delivered through the abdominal wound, divided, and ligated. Exploration at this point revealed a large cavity extending up underneath the diaphragm and refused to separate was caught between two clamps, divided, and ligated. Exploration at this point revealed a large cavity extending up underneath the diaphragm and down in the pelvis and the kidney situated in the upper and anterior portion of this cavity. Nephrorrhaphy was done by the method of Edebohl. Wound was closed in layers with drain down in the lower portion of this large cavity.

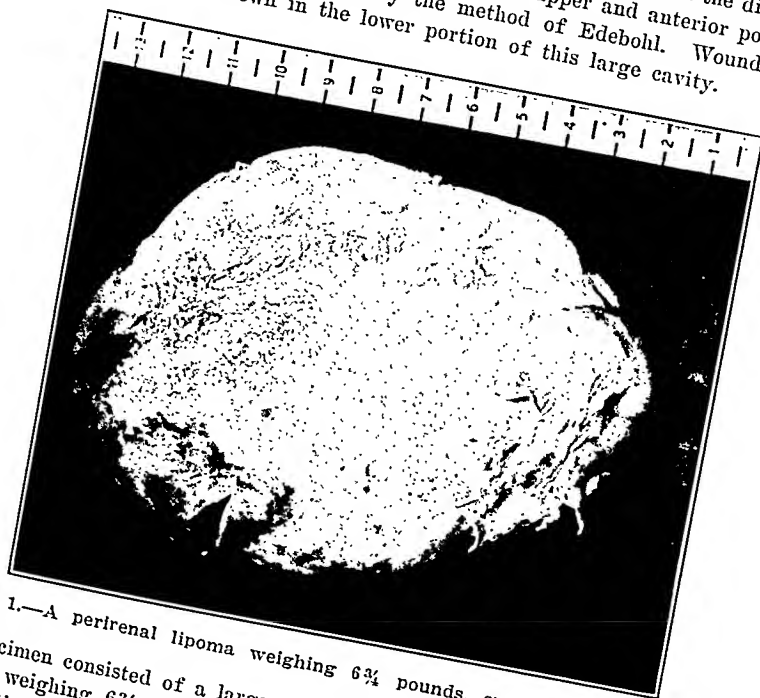


Fig. 1.—A perirenal lipoma weighing 6¾ pounds, successfully removed.

The specimen consisted of a large mass of fatty tissue, measuring 30 by 25 by 8 cm. and weighing 6¾ pounds. The entire tumor was covered with a delicate connective tissue membrane, which could be considered a capsule. On section, it was found to be made of normal appearing fatty tissue with a suggestion of gross lobulation. Microscopic examination of sections taken from various parts of the tumor revealed normal fat cells enclosed in a delicate connective tissue.

The patient had a satisfactory postoperative course and was discharged on March 28, 1939.

DISCUSSION

The diagnosis of perirenal lipoma is rarely made preoperatively. Its rarity and the lack of early and significant symptoms probably account

for this fact. The diagnosis rests on finding a large abdominal tumor, soft and semifluctuant, with little or no mobility, extending into the flank in the region of one or both kidneys and presenting a history of slow growth. A thorough cystoscopic and pyelographic study is helpful in differentiating this tumor from those of kidney, ovary, pancreas, and intestine. However, an accurate diagnosis is not essential as the presence of a tumor with or without symptoms should be sufficient indication to perform exploration.

Various theories have been advanced as to the nature of the pathologic process responsible for lipomas, but the etiology of these tumors is unknown. There is a striking tendency for these tumors to occur in certain locations. In the male they are particularly common around the neck, and in the female they appear most frequently in the breast. They also occur retroperitoneally, and in this latter group the most common sites of origin are the fat about the kidney, at the root of the mesentery, about the colon, and in the pelvis. They vary in size greatly, from small, well-defined nodules, 1 cm or so in diameter up to huge tumor masses. The tumors are usually lobulated, soft or semifluctuant, and of normal fat color, surrounded by a delicate connective tissue capsule. On cut sections, they are often solid and of a yellow color, but there may be areas of hemorrhage, degeneration, or sarcomatous change. Histologically, these tumors are almost wholly of normal appearing fat cells. However, a careful search should be made for malignant changes as a large percentage of reported tumors has shown such tendencies.

CONCLUSION

A case of excision of a perirenal lipoma is reported, the patient making a satisfactory recovery.

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Editorial

When to Operate in Gall-Bladder Disease

AN INCREASED knowledge of the sequence of pathologic events in acute and chronic cholecystitis makes possible certain definite statements about the optimum time for operation. In acute cholecystitis with stones a common course is the following: A stone becomes impacted in the ampulla at the cystic duct, obstruction of the submucous veins and lymphatics causes edema and swelling of the mucosa and surrounding structures. Infection supervenes later with interference with the cystic artery, veins, and lymphatics. The production of mucus causes increased pressure within the gall bladder and this, combined with the circulatory disturbance, results in local or general gangrene of the mucosa, thickening of the gall-bladder wall, and petechial hemorrhages into it. Local gangrene precedes perforation, peritonitis, or pericholecystic abscess. A thrombosis of the cystic artery may cause general gangrene of the gall bladder. In exceptional cases this occurs very early.¹⁻⁴

The clinical course of these cases in the first few days is not that of an active infection; cultures from the contents of the gall bladder and its wall are frequently sterile and removal of the gall bladder is followed by a prompt recovery without complications. Thoughtful consideration of the pathology as described above would logically lead to a prompt operation as soon as a definite diagnosis can be made.

A second type of acute cholecystitis due to embolic infection of the gall-bladder wall with microorganisms might cause more disagreement. In the acute fulminating cases most surgeons would consider operation imperative, but many would feel that delay was indicated in the less severe infections, especially in cases seen late. There are mortality statistics available to guide us in our decision. In a collected series of 167 cases of acute cholecystitis with operation within forty-eight hours of the onset of symptoms, there was a mortality of 3.6 per cent.⁵ In one series of 100 consecutive cholecystectomies for acute cholecystitis, operation within the first five days on seventy-eight cases gave a death rate of 5 per cent.⁵ The deaths in this series came from suppuration and perforation in three out of the four cases. Obviously those patients who died from early operation were the fulminating cases. After five days the death rate rises rapidly in many of the published series to about 20 per cent, so this still remains a "no man's land" for further experiment and debate. Complicating diseases may compel delay at

times. We have not taken into consideration the well-known difficulty or impossibility of accurately determining the type of pathology present before operation.

In chronic cholecystitis and cholelithiasis the need for haste in saving hours or a few days is secondary, but this is a progressive disease and procrastination over a period of years has wrought deadly havoc in the past. Stones in the common duct, pancreatitis, and liver destruction are a few of the end results. Goldish and Gillespie⁶ have shown that the average age of those who died following gall-bladder operations was 10 years older than those who lived. Glenn⁷ states that in the New York Hospital group "in 69 patients with symptoms for less than one year no post-operative death occurred and there were 53 cases of acute cholecystitis whose symptoms had endured less than five years who survived operation. With a history of more than five years of gall-bladder disease the mortality after operation was 15 per cent."

Inflammation of the gall bladder associated with chronic jaundice has been treated in the past by most surgeons with an elastic and prolonged delay, inspired by the hope that a remission would occur during which a safer operation could be performed. Too often the jaundice has increased with more extensive liver damage and increased risk. The time has now come when these deeply jaundiced patients can be operated upon with a low mortality and freedom from postoperative hemorrhage after a few days' preparation. This change has been brought about by the use of vitamin K,⁸ bile salts, transfusions, and glucose solutions.

With all these facts in mind, who can doubt that it can be truly said of gall-bladder surgeons: "The bravest are the tenderest; the loving are the daring"?

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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

RECENT ADVANCES IN SURGERY OF THE ESOPHAGUS

CLARENCE E. BIRD, M.D., PROVIDENCE, R. I.

(Continued from the November issue)

HEMORRHAGE FROM ESOPHAGEAL VARICES

The development of an adequate technique for the demonstration of esophageal varices by the air-contrast relief method (Wolf, 1928; Schatzki, 1931; Brdiczka and Tschakert, 1932; Baumeister, 1933; Wachner, 1934; Holmes and Schatzki, 1935; Monaumi, 1937; Plotz and Reich, 1938) has progressed side-by-side with attempts to control hemorrhage from them by rational operative means.

The largest and most extensive varices are seen in cases of thrombosis of the splenic and portal veins (Brdiczka and Tschakert; Baumeister). Lesser degrees of involvement are observed in cirrhosis of the liver, Banti's syndrome, the varices of old age, and in the congenital cases (e.g., Nochimowski, 1932). In all unexplained cases of gastrointestinal bleeding roentgenologic examination of the esophagus should be made. Wachner (1934) stated that bleeding and death may occur from varices in cases in which it is impossible to demonstrate them by roentgenography, but Holmes and Schatzki implied that by careful observation even the small varices may be detected. At fluoroscopy, differentiation must be made between varices and air pockets, esophagitis and carcinoma. Air pockets can be displaced and are readily recognized after a little experience. Varices and the walls of the esophagus about them change shape with variations in intrathoracic pressure (tests of Müller and Valsalva), but inflammatory and carcinomatous infiltrations show localized or generalized rigidity.

In a patient with Banti's syndrome Walters, Rowntree, and McIndoe (1929) attempted to control bleeding from esophageal varices by ligating the coronary vein and its branches. This was unsuccessful, but after the spleen had been removed (Rowntree, Walters, and McIndoe, 1929), the hemorrhages stopped, at least temporarily. Kirklin and Moersch (1931) reported the case of a male, aged 26 years, in whom a large spleen was removed because of bleeding from varices which were demonstrated by roentgenography; the coronary veins were not ligated because they were not distended at the time of operation. Three weeks later, the roentgenologic appearance was unchanged. These experiences led Kegaries (1933, 1934) to study the venous plexus of the esophagus in detail, following which he advised, for patients with portal obstruc-

times. We have not taken into consideration the well-known difficulty or impossibility of accurately determining the type of pathology present before operation.

In chronic cholecystitis and cholelithiasis the need for haste in saving hours or a few days is secondary, but this is a progressive disease and procrastination over a period of years has wrought deadly havoc in the past. Stones in the common duct, pancreatitis, and liver destruction are a few of the end results. Goldish and Gillespie⁶ have shown that the average age of those who died following gall-bladder operations was 10 years older than those who lived. Glenn⁷ states that in the New York Hospital group "in 69 patients with symptoms for less than one year no post-operative death occurred and there were 53 cases of acute cholecystitis whose symptoms had endured less than five years who survived operation. With a history of more than five years of gall-bladder disease the mortality after operation was 15 per cent."

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terfere with the passage of instruments. Biedermann's esophagoscope resembles the instrument of Jackson, but it is fitted with an optical light staff, 3.6 mm. in diameter, which is inserted through the main lumen to enlarge the field by 2.5 times and bring the image closer to the eye. He has been able to use instruments with great accuracy through the part of the tube not filled by the light staff.

Tucker (1934) described a small, long esophagoscope to be passed through and beyond a 9 mm. tube of usual Jackson design. This enabled him to enter and pass quite small zones of stenosis in the lower esophagus under conditions of improved visibility and control. In 1936 he also recommended rigid esophagogastroscopes, 6 mm. in diameter and 53 cm. long for children, and 8 mm. in diameter and 58 cm. long for adults, each provided with a combined thumb valve suction release and stopcock and a stopcock insufflation tube. He advised the examination of the esophagus with a rigid tube before the introduction of a flexible gastroscope, even if the x-ray studies had been negative, in order to rule out contraindications to the blind passage of the instrument.

Matis (1935) made use of a tube which combined the advantages of proximal (Brünings, 1909) and distal (Jackson) illumination. He felt that this helped prevent distortion and assisted him in the delicate use of instruments. In 1937, he reported that he had been experimenting with various models of flat-oval, oval, and quadrilateral distensible esophagoscopes, made in two parts which could be separated gradually after introduction. The flat-oval type seemed the best and presented many advantages over the older round tubes with lumens of fixed size.

ROENTGENOGRAPHY

Taken as a whole, the development of the art of roentgenography of the pharynx, esophagus, cardiac portion of the stomach, and the small intestine has not kept pace with the perfection obtained in examination of the lower portion of the stomach, the proximal duodenum, and the colon. However, a few roentgenologists have become interested in the special problems presented by alterations in physiology and morphology in these regions and have developed techniques which enable a careful observer to attain a high degree of accuracy in diagnosis.

Particular attention has been paid to the upper esophagus by roentgenologists who are connected with the large laryngologic centers (e.g., Pancoast, 1924, 1933; Eiselsberg and Sgalitzer, 1928; Macmillan, 1939). By a close study of the normal and abnormal appearances in the anteroposterior, oblique, and lateral positions, with and without the aid of contrast mixtures, the services of the roentgenologist have been much improved. For the mid- and lower esophagus and the region of the cardia, special attention has been directed to the importance of examining patients in several positions. The advantages of the Trendelen-

tion who had bled from esophageal varices, the ligation of the coronary veins and the vasa breva of the spleen together with a Talma-Morrison omentopexy, with or without splenectomy, according to the ability of the patient to withstand a more extensive procedure. McClure (1934) ligated the coronary veins and, five and one-half months later, removed the spleen, with apparent relief in a case of hematemesis in Banti's disease. In a boy, aged 7 years, with Banti's syndrome, who had bled seriously from large varices which were demonstrated by roentgenograms, Rhoads and Stein (1938) ligated the coronary vessels and removed the spleen, with clinical improvement and reduction in the size of the varices as seen by roentgenography. They thought that ligation of the coronary artery might have decreased the load on the portal system, but, in view of the rich collateral distribution of blood to the stomach, this seems rather unlikely.

Kemp (1938), in a most interesting critical analysis, concluded that the crux of the situation lies, not in the ligaturing of the coronary veins and in splenectomy or tying of the splenic pedicle alone, but in the development of methods by which the dilated veins may be attacked directly. He pointed out that in cases of varix of the internal saphenous system a cure is not attained by distal ligation and that analogously distal ligation scarcely can be expected to provide much relief in cases of established varices of the esophagus, in which the columns of blood are in direct connection with the superior vena cava and unprotected by valves. Seeking to attack the problem directly, Walters (1933) suggested the injection of sclerosing solutions into or about the dilated veins through an esophagoscope. Kemp implied that it might be possible by a transthoracic approach to ligate the dilated veins proximally (i.e., the azygos and hemiazygos). If this should be done, it would be advisable, of course, as a preliminary step to ligate the coronary veins and vasa breva and to carry out omentopexy, with or without splenectomy.

In emergencies Westphal (1930) succeeded in stopping hemorrhage from varices in two cases of cirrhosis of the liver by introducing a Gottstein bag and filling it with 80 c.c. of water. The pressure was maintained for twenty-four to twenty-nine hours. He suggested the use of sedatives if the bag caused discomfort.

NEW ESOPHAGOSCOPIC INSTRUMENTS

Several instruments have been described during the past five years which may perhaps possess advantages over the older models. Korbseh (1934, 1938), Israel (1935), and Biedermann (1938) each designed instruments which make use of lenses to magnify and proximate the image. The flexible model of Korbseh is only 6 mm. in diameter and can be used to examine minutely the mucous membrane of the esophagus, the cardia, and the pyloric portion of the stomach. The telemagnifier of Israel can be focused, does not obstruct breathing, and does not in-

Moore (1930) noted that in the examination of the lower esophagus and region of the cardia the roentgenologist is chiefly concerned with the differentiation between carcinoma, cicatricial stricture, achalasia, diverticula, nonmalignant new growths, ulcers, and diaphragmatic hernias. The limitations of roentgenography, as well as esophagoscopy, in the detection of lesions of the esophagus were emphasized by Emery (1934), who stated in substance that: "Symptoms typical for carcinoma are more dependable than a negative roentgenologic and esophagoscopy report. All patients who complain of indefinite esophageal symptoms should be studied by the x-rays and esophagoscope and if symptoms persist, examinations should be repeated at least once a month until a diagnosis is made." Pesek (1934) and Barnes (1937) also advised re-examinations. The danger of misinterpreting, as achalasia, certain cases of carcinoma was pointed out by Vinson (1924). Collins (1934) noted that scarring with superimposed spasm may give an appearance almost identical to that of carcinoma. Jackson (1935) found that hiatal hernia complicated by ulcer may easily be mistaken for cancer of the lower esophagus. Many authors have emphasized that negative findings by x-ray are unreliable unless checked by esophagoscopy (e.g., Hill, 1925; King, 1936). On careful examination by Schatzki's (1931) method in his cases of ulcer, Macmillan (1935) observed under the fluoroscope considerable spasm of the esophagus and often a fleck of barium remained in the affected area. However, many esophageal ulcers do not show the deformity and niche which are so typical of duodenal ulcer. If epigastric or substernal pain persists, esophagoscopy is always indicated (Jackson, 1929).

The possibility of obtaining information as to the state of adjacent organs or tissues by roentgenographic studies of the barium-filled esophagus has been recognized for many years. Recent contributions, particularly in relation to deviations caused by an enlarged left auricle in mitral and aortic disease, have been made by Rösler and Weiss (1925), Brown and McCarthy (1935), Schwedel (1937), and Conrads (1937). Graham, Singer, and Ballon (1935) illustrate a diminution of the deviation of the esophagus as a result of a Brauer operation in a case of large rheumatic heart. Deviations, stenoses, and fistulas due to various extrinsic changes, such as pulmonary tumors, neoplasms of the vertebrae, cold abscesses, aneurysms of the great vessels, a high right-sided anomalous position of the aorta, and pleural exudates, have been noted. Fell and Goldschlag (1935) and Doig (1936) report cases in which enlarged or fibrosing tuberculous mediastinal lymph nodes displaced the esophagus. In one of Doig's cases the angulation was so abrupt as to cause dysphagia. He suggested the possibility of a thoracoplasty for its relief, should the dysphagia become serious. Blalock (1935) noted that, at least in dogs, total pneumonectomy, without associated paralysis of the diaphragm, was followed by a marked deviation of the esophagus to the side from which the lung was removed.

burg (pelvis-high) posture were emphasized by Palugyay (1920, 1923) and Schatzki (1931). Manges (1926) advocated the right oblique prone position for adults and the supine posture for children (Manges and Clerf, 1935). It seems likely that routine fluoroscopy in these positions will unearth the causes of many obscure thoracic and abdominal complaints. Details cannot be entered into here, but the object of the special positions is to fill the esophagus with barium and obtain good fluoroscopic and spot film views (Kruchen, 1929; Schatzki) of all portions, without too much overlapping by other structures, such as the spine, heart, and fundus of the stomach. By proper techniques, filling can often be obtained below as well as above partially obstructing lesions (Moore, 1930). Wright and Freeman (1934) obtained good filling of the unobstructed esophagus in the upright position; they directed the patient to swallow two or three mouthfuls of barium mixture during forced expiration and exposed a film immediately. In a few patients with incipient or established achalasia of the cardia better films were obtained during forced inspiration.

The gelatin or barium-filled capsules introduced for esophageal work by Hickey (1929) were found misleading by Barnes (1937), but the opaque gelatin bougies appeared to be useful. Various thick and thin mixtures of barium, many of them containing sticky substances, such as mucilage, acacia, or tragacanth, or small dry bodies like cracker crumbs have been used to assist visualization (e.g., Vinson, 1925; van Gilse, 1928; Collins, 1934; Barnes, 1937).

Macmillan (1935) was able to demonstrate all of his foreign bodies lodged in the esophagus: "If the foreign body is not located on the lateral view, a search must be made for it with the aid of a heavy barium paste, for if present the barium will adhere to it and will not be washed off by subsequent swallowing of water. If there is edema and scarification of the mucous membrane from trauma in the passage of the foreign body, there will be delay in the transit of the barium and a variation from the normal mucosal pattern, but one or two swallows of water will wash off the barium from any such area of abrasion." This method was mentioned favorably by Nissen (1934). Roentgen technique in cases of suspected perforation of the esophagus by foreign bodies or instruments was ably described and illustrated by Schiffer (1935).

Schatzki (1931) published beautiful films in various normal and pathologic conditions made by the mucosal relief (air contrast) method. This technique is particularly useful for the demonstration of esophageal varices, but Schatzki also detected the swollen folds of esophagitis, the converging folds and the small niche of an ulcer, and the slight irregularities of early carcinoma, which might not be evident by methods which depend on complete filling. The procedure was found valuable by Skinner (1937).

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The occurrence of peristalsis in the esophagus has been demonstrated repeatedly by both physiologists and roentgenologists, but the question of antiperistalsis (during vomiting or as the result of obstruction or spasm) is still subject for debate. Largely on the basis of roentgenologic observations in human beings and in dogs, Beechini (1935, 1937) and Aprile (1937) agreed with several earlier authors that true antiperistalsis occurs not infrequently. Dahm (1938), on the other hand, using the roentgenkymograph, demonstrated to his own satisfaction that Schwartz (1924) was correct when he interpreted the apparent antiperistalsis as a reflux of barium, which, encountering obstruction, passed backward through the lumen as the advancing forward wave of peristalsis approached and passed the obstructed region.

Jackson and Jackson (1933) pointed out that lesions of the esophagus frequently cause cough by reflex irritation or by entrance of esophageal contents into the respiratory tree. In the latter event fluoroscopy shows barium entering the bronchi through a tracheoesophageal or bronchoesophageal fistula or by overflow from an obstructed esophagus directly into the larynx and trachea. Other causes of such an overflow are bulbar paralysis, compression of the ninth and tenth nerves at the base of the skull, and myasthenia gravis.

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Book Reviews

Pye's Surgical Handicraft. Edited by Hamilton Bailey, M.D. Ed. 11, revised. Cloth. Pp. 500, with 362 illustrations. Baltimore, 1939, Williams and Wilkins Company. \$6.

This small compendium of hospital procedures which has been republished periodically for fifty-four years has undoubtedly introduced many a surgeon into the intricacies of the surgical art. When the reviewer was first a surgical house officer, an earlier edition of this book was constantly by his bedside and was consulted frequently. It contains an extraordinary variety of practical materials, all dealt with concisely and all pertinent to the management of surgical cases. It is illustrated profusely. A large number of contributors writing on subjects of their special interest lends assurance that the subject matter is dealt with in an up-to-date and authoritative manner. This book should have a wider acquaintance among American readers.

Diseases of the Nose and Throat. By Charles J. Imperatori, Professor of Otolaryngology, New York Polyclinic Medical School and Hospital, and Herman J. Burman, Adjunct Professor of Otolaryngology, New York Polyclinic Medical School and Hospital. Ed. 2. Pp. 700, with 480 illustrations. Philadelphia, 1939, J. B. Lippincott Company. \$7.

The first edition of this text was published in 1935. It was so well received that the authors have brought this second edition up to date to include the progress made in rhinolaryngology.

This text is an outline of the subject of nose and throat disease. The authors indicate that it represents essentially the course which has been given to matriculates of the New York Post-Graduate Medical School of Columbia University. In this outline form, symptoms, diagnosis, and treatment are considered first and etiology and pathology are placed at the end of each discussion. All of the information is condensed in a series of statements in paragraph arrangement. For example, the subject of acute rhinitis is discussed in five pages in the following order: symptoms, diagnosis, treatment, complications, pathology, etiology, prophylaxis, and treatment. There is no critical evaluation of ideas other than the authors' own. Thus it lacks the completeness of the orthodox text.

The outline is rather complete. There are fifty-two chapters in all. There is a discussion of sinusitis as a focus of infection, physical therapy and radiation, allergy, manifestations of general diseases, and laboratory aids. The illustrations are ample for a treatise of this type and are practical ones. Considerable detail is given to office procedure and the technique of treatment. The subject of pathology is proportionately considered.

For the student and practitioner this text offers a very readable and practical outline of what the majority of rhinologists and laryngologists accept as fact, carefully arranged by these two well-known specialists.

Septische Chirurgie. By Dr. Med. Habil. Fritz Schorcher, Universitat Munchen. Paper. Pp. 270, with 74 illustrations. Leipzig, 1938, Johann Ambrosius Barth. RM 20 unbound, RM 21.50 bound.

This small monograph deals with the various suppurative processes which fall within the province of the general surgeon. The subject matter has been discussed in an orthodox and authoritative manner. The drawings of surgical exposures are particularly good. One weakness of the text relates to rather sketchy management of a number of disorders, but the most serious omission is failure to include any discussion of the pertinent literature or to list any bibliographic references. The author has brought together in one text the surgical problem of infection in its various manifestations.

Surgical Applied Anatomy. By Sir Frederick Treves. Ed. 10 revised by Lambert Rogers, M.D. Fabricoid. Pp. 748, with 192 illustrations, including 66 in color. Philadelphia, 1939, Lea and Febiger. \$4.50.

Applied anatomy, according to the late Sir Frederick Treves, has a twofold function. "First, it serves to give a precise basis to those incidents and procedures in practice that more especially involve anatomical knowledge; and secondly, it endues the dull items of that knowledge with meaning and interest by the aid of illustrations drawn from common medical and surgical experience."

With these objects in mind, the present reviser, Mr. Lambert Rogers, has done a creditable job. The contents are divided into six parts, covering the head and neck, the thorax, the upper extremity, abdomen and pelvis, lower extremity, and the spine and spinal cord. The book is intended mainly for the use of students preparing for their final examinations in surgery. The more practical details of anatomy are stressed. The clinical and pathologic examples are well chosen. Detailed accounts of the anatomy of hernia and surgery of arteries are left to larger systematic treatises.

The book is pocket size, but the print is very readable. The illustrations and diagrams are excellent. An index is appended. Undoubtedly this popular volume will go through many future editions.

Diseases of Women. By Ten Teachers. Edited by Sir Comyns Berkeley, M.S., M.D., B.Sc., Lond., F.R.C.S., etc., Consulting Obstetrical and Gynecological Surgeon to the Middlesex Hospital. Ed. 6. Cloth. Pp. 492, with 158 illustrations. Baltimore, 1938, Wm. Wood & Co. \$6.

This new work has been produced by collective authorship, the ten contributors being prominent figures in gynecology and obstetrics, not only in England but also in this country. All in all, the work is fairly comprehensive, although several subjects are presented in a rather cursory manner, which may be sufficient for the needs of the medical student but certainly not for the gynecologist.

The subject is presented in the usual logical manner, the opening chapters being devoted to anatomy, embryology, and physiology of the generative tract. A discussion of puberty, amenorrhea, menopause, and menstrual irregularities then follows.

The sections on the physiology and disorders of menstruation have been rewritten, bringing up to date the newer concepts in the field of reproductive endocrinology.

The discussion of malpositions of the uterus includes the recommendation of the Aveling repositior for the use of uterine inversion, which to my knowledge is not the accepted procedure in this country; however, it would seem worthy of trial.

The next section deals with inflammatory processes of the generative tract, which includes a discussion of chronic metritis, chronic subinvolution, and simple hypertrophy of the uterus, conditions as a rule not sufficiently dealt with in most textbooks.

Considerable space is given to the consideration of the benign and malignant tumors of the uterus and ovary. The chapter on carcinoma of the cervix is fairly complete, although the portion devoted to pathology would seem too brief. The chapter devoted to tumors of the ovary is comprehensive, clearly presented, and fully illustrated.

The remaining chapters are mainly taken up with the consideration of extra-uterine pregnancy, contraception, and operative procedures.

The book is written in a lucid, concise style, which is characteristic of so many English authors. The type is clear, and, although the illustrations are numerous, they are not particularly well done. The value of the publication would be enhanced by the addition of a bibliography. The work is quite worth while and should prove of considerable value to the student of gynecology.

Treatment by Manipulation. By A. G. Timbrell Fisher, N.C., M.B., Ch.B., F.R.C.S., England. Ed. 3. Cloth. Pp. 255, with 68 illustrations. New York City, 1939, Paul B. Hoeber, Inc. \$3.75.

Timbrell Fisher stated in his preface to the third edition of this monograph that his purpose was to call to the attention of the medical profession the great importance and value of manipulative treatment in the management, in carefully selected cases, of certain sequelae of injuries and diseases, particularly affecting the joints, muscles, tendons, and fascia. This purpose has been adhered to in the third edition, which has been enlarged and altered to bring the subject matter up to date.

The chapter on osteopathy deals with the history of and fallacies in this cult. The difference between manipulative surgery, as practiced by qualified medical practitioners, and osteopathy, a revolutionary system of medicine, based upon a theoretical hypothesis unsupported by scientific evidence, is clearly drawn.

The three chapters devoted to a discussion of the pathology, the prevention, and the diagnosis of adhesions are excellent and emphasize fundamentals with which those who attempt to treat disturbances of the joints, tendons, and fascia should be thoroughly familiar. Perhaps the most important section of these chapters is that which deals with the role of early movements in sprains, fractures, arthritis, and other conditions leading to limitation of movement and deformity in joints. The views expressed are based on an extensive experience and intelligent observation and are worthy of study by every practicing physician, be he specialist or general practitioner.

The chapter dealing with the general principles of manipulative treatment and the application of these principles to individual joints presents subject matter in a clear-cut, systematic manner. The technique of the manipulations to be carried

out for each joint is carefully described and clearly demonstrated by the accompanying illustrations. The final chapter on aftertreatment is brief but full of important and useful information.

Fisher has handled a delicate subject in a masterly manner; he has been conservative in the claims he makes for treatment by manipulation and has clearly pointed out its limitations and its dangers. This book has placed treatment by manipulation in its legitimate place in the armamentarium of the practicing physician, and makes an excellent case for including instruction in this important therapeutic measure in our medical curriculum.

Surgical Pathology. By William Boyd, M.D., University of Toronto. Cloth. Pp. 886, with 476 illustrations and 15 color plates. Philadelphia, 1938, W. B. Saunders Company. \$10.

The fourth edition of Boyd's *Surgical Pathology* has been revised to cover all the important new contributions in this field. The book is more than a surgical pathology. It is in reality a guide to surgical procedures which have been found to be of practical value. In many chapters there is a discussion of theories of disease processes. The presentation of the clinical features of various disorders makes the book one which has an appeal to the practicing surgeon. The author has a pleasant, clear style so that the book is easy to read. In attempting to cover detailed gross and microscopic pathology in a volume of this size, it is necessary to be dogmatic. For this reason controversial issues in the pathologic field sometimes are avoided or dismissed with little discussion. Occasional discrepancies are bound to creep in such as that on hypernephroma. On page 192 "hypernephroma is a tumor consisting of adrenal tissue," but on page 440 the term is used "with the clear understanding, however, that the use of this name does not commit one to the adrenal theory of the origin of these tumors."

There are many excellent new illustrations. It is disappointing to find some rather stereotyped drawings retained from the earlier editions. These should be replaced by photomicrographs in future editions.

The general outline of the presentation is for anatomical regions. The pathologic conditions of surgical interest in each organ are taken up in an orderly fashion. The active surgeon will find the book a valuable *vade mecum*.

The section on adrenal conditions might be revised for a clearer presentation. In view of their increasing frequency a section on the tumors of the lungs and bronchi would seem to be in order. With these minor exceptions, this edition of *Surgical Pathology* answers most of the questions of interest to the surgeon. It stands between the books on general pathology and the monumental work of Ewing on *Neoplastic Disease*.

The Rectum and Colon. By E. Parker Hayden, Assistant Surgeon and Chief of Rectal Clinic, Massachusetts General Hospital. Cloth. Pp. 434 with 169 illustrations. Philadelphia, 1939, Lea & Febiger. \$5.50.

This well-printed and illustrated book apparently reflects the experience and beliefs of the Rectal Clinic of the Massachusetts General Hospital whose staff is composed entirely of surgeons who have been functioning in this capacity for varying periods of time for the past ten years. The author states in the preface that he has made an effort to give each pathologic condition that degree of emphasis which its relative importance warrants without attempting to include in the bibliography all of the important references bearing on a subject.

One is struck with the forthright exposition of the subject. No effort is made at finality of opinion, but the various conditions are described and discussed with candor and at the same time reflect the author's personal viewpoint. The reader, whether he is seeking information on the subject or simply is interested in the viewpoint of the Clinic can be assured good reading. For instance, the experience of the Massachusetts General Hospital in ulcerative colitis is well given in the quotation from McKittrick's work. The influence of the late Daniel Jones is shown in the sound consideration of the management of cancer of the rectum.

For the general practitioner the book offers a systematic and entirely sound approach to the management of the important lesions involving the rectum. The injection treatment of hemorrhoids is discussed at length with, I believe, insufficient emphasis on the palliative rather than curative nature of the results. The descriptions of the operative methods for hemorrhoids are good but fail to give the clamp and cautery method what some might think a fair appraisal. A careful and critical discussion of oil-soluble anesthetics as well as their formulas are given. The advocacy of operation for acute thrombosis of hemorrhoids is against the usual practice but is sound. Prolapse of the rectum is well considered. In the discussion of lymphogranuloma inguinale many surgeons of experience would take real exception to the advisability of resection of the rectum for its cure. The omission of the mention of the Strauss proctoscope in the description of those instruments or of Sudeck in the discussion of the critical point of ligation of the superior hemorrhoidal artery is not important except where others are given credit for their contributions.

In general the above criticisms are not fundamental, for the principles and practice outlined in this book on the colon and rectum are sound and should be of great value to the general practitioner and surgeon who needs information on the subject.

End Results of the Treatment of Gastric Cancer. By Edward M. Livingston, M.D., and George T. Pack, M.D. Cloth. Pp. 179, with 145 illustrations, New York, N. Y., 1939, Paul B. Hoeber, Inc. \$3.

This unusual and remarkable book will lend considerable encouragement to the problem of cancer of the stomach. The authors have summarized the world's literature of 14,000 reported gastric resections. The average mortality rate for resection is slightly under 20 per cent. Of patients who survive resection, 20 per cent will be alive and well after five years. To those familiar with the papers of Welch and of Friedenwald, this is encouraging information. The lamentable matter, which is not always apparent in surgical figures, but which the authors have been at pains to point out, is that the nonoperable, as well as the nonresectable, group is very large.

The plan of the book is unique and should prove a good prototype for surgical monographs. The authors have departed widely from the usual orthodox plan of writing. Tables and concise listing of pertinent information should make the book very useful, not alone to surgeons but to internists and practitioners as well. The choice of bibliographic references is good. Without question, this is one of the best monographs on cancer of the stomach that has ever been published and should be read widely.

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